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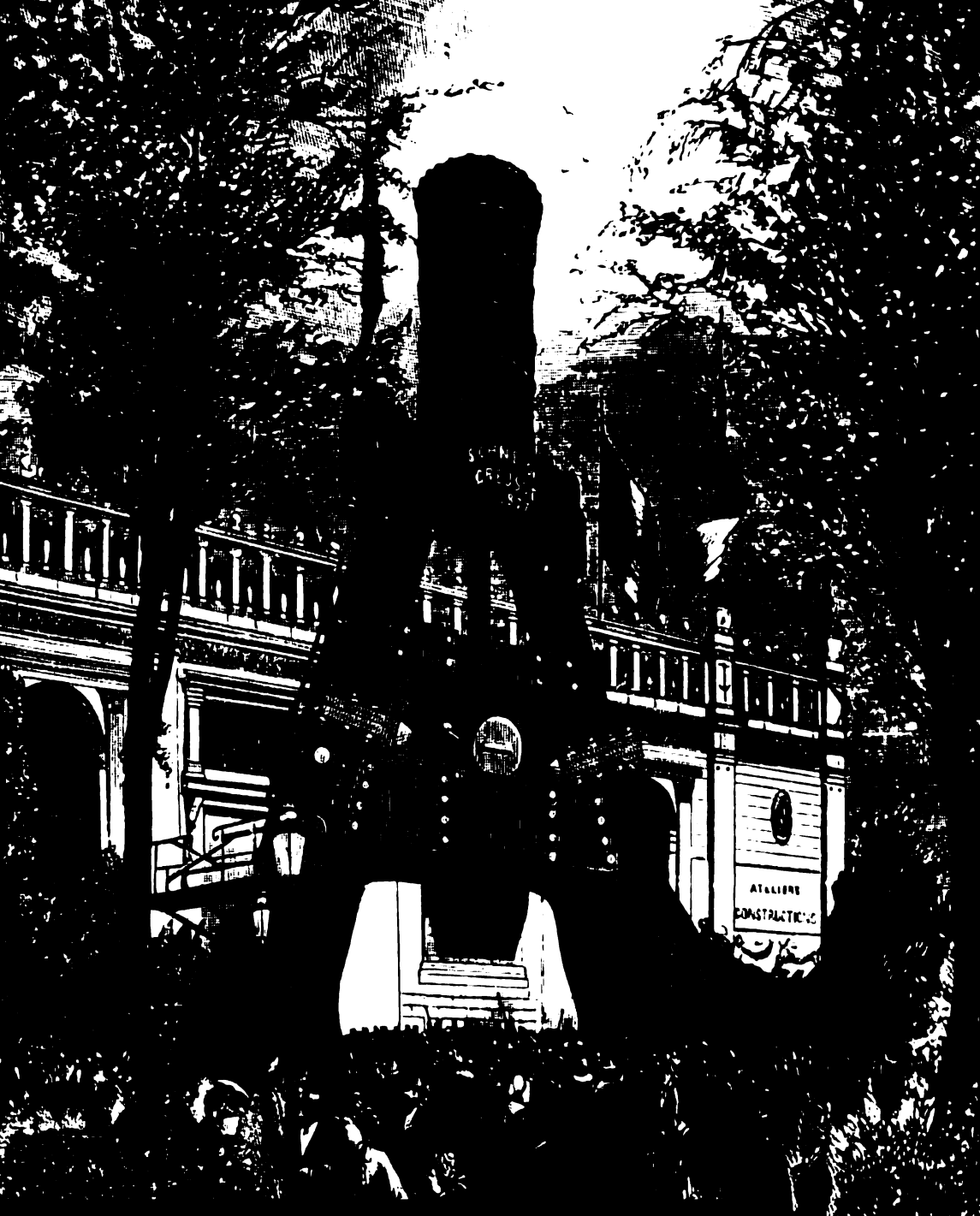

Reports of the United States commissioners to the Paris ...

United States. Commission to the Paris exposition, 1878, Edward Henry Knight

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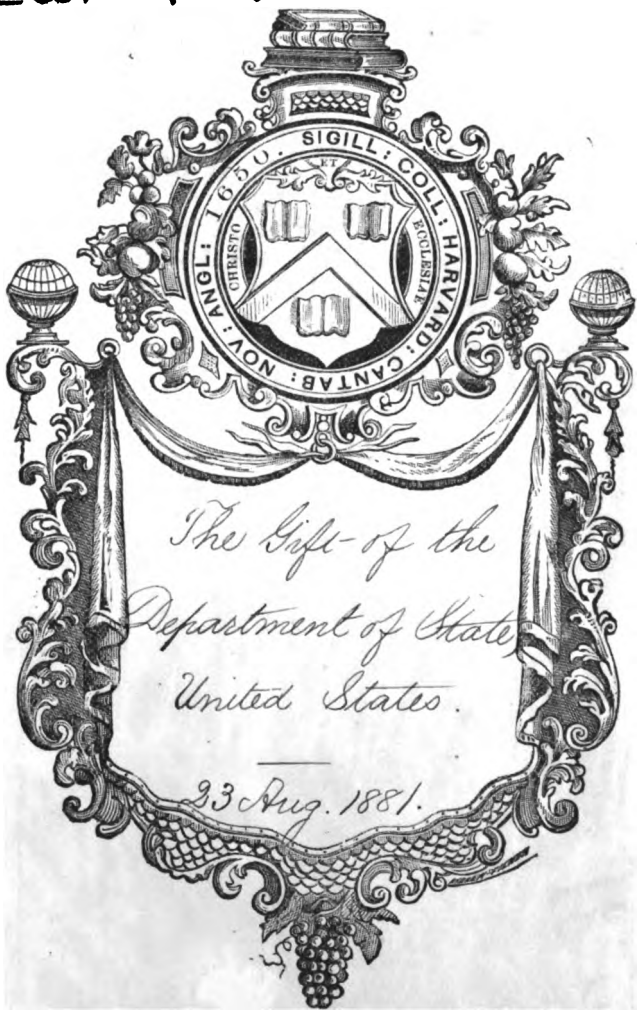

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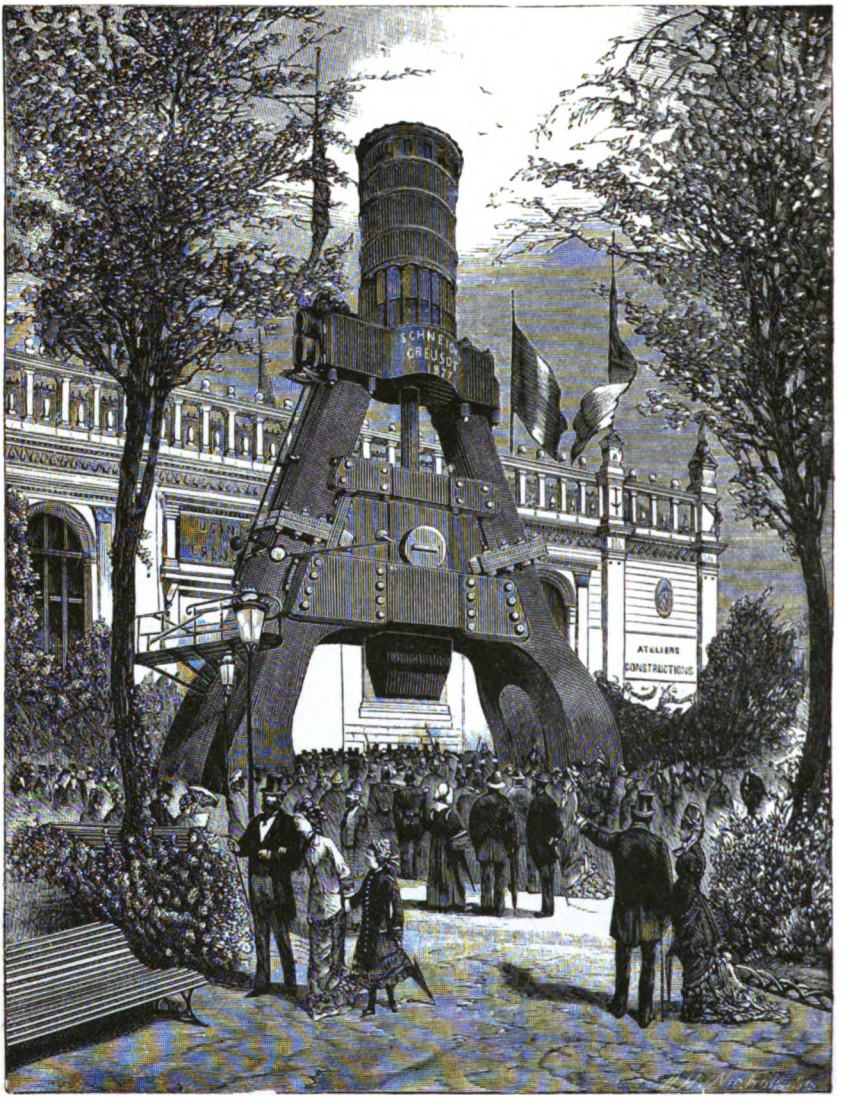

PAVILION AND MODEL OF EIGHTY-TON STEAM HAMMER.

Schneider & Co., Creusot.

(For description, see page 7.)

[Frontispiece to vol III.]

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REPORT

OF THE

UNITED STATES COMMISSION

TO THE

PARIS UNIVERSAL EXPOSITION,

1878.

PUBLISHED UNDER THE AUTHORITY OF AN ACT OF CONGRESS APPROVED MARCH 3, 1879.

VOLUME III.

IRON AND STEEL; CERAMIC ART; GLASS.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1880.

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REPORTS

OF THE

UNITED STATES COMMISSIONERS

TO THE

PARIS UNIVERSAL EXPOSITION,

1878.

PUBLISHED UNDER DIRECTION OF THE SECRETARY OF STATE
BY AUTHORITY OF CONGRESS.

VOLUME III.

IRON AND STEEL, CERAMICS AND GLASS, FORESTRY, COTTON.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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IRON AND STEEL EXHIBITS.

HON. DANIEL J. MORRELL.

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[Extract from the Official Classification.]

FIFTH GROUP.—MINING INDUSTRIES, RAW AND MANUFACTURED PRODUCTS.

CLASS 43.—MINING AND METALLURGY.

Collections and specimens of rocks, minerals, ores. Ornamental stones. Hard stones. Refractory substances. Earths and clays. Various mineral products. Raw sulphur. Rock salt; salt from salt springs.

Mineral fuel: various kinds of coal, coal-dust, and compressed coal. Asphalt and rock asphalt. Bitumen. Mineral tar. Petroleum, etc.

Metals in a crude state: pig-iron, iron, steel, cast steel, copper, lead, silver, zinc, etc. Alloys.

Products of washing and refining precious metals, of gold-beating, etc.

Electro-metallurgy: objects gilt, silvered, or coated with copper, steel, nickel, etc., by the galvanic process.

Products of the working of metals: rough-casting, bells, wrought iron, iron for special purposes, sheet-iron and tin plates, iron plates for casing ships and constructions, etc.

Sheet-iron coated with zinc or lead; copper, lead, and zinc sheets, etc.

Manufactured metals: blacksmith's work, wheels and tires, unwelded pipes, chains, etc.

Wire-drawing. Needles, pins, wire ropes, wire work, and wire gauze, perforated sheet-iron.

Hardware, edge-tools, ironmongery, copper, sheet-iron, tin ware, etc.

Other metal manufactures.

[The writer desires to acknowledge the valuable assistance of Mr. James M. Swank, the Secretary of the American Iron and Steel Association, in the collection of the historical and statistical information contained in this report.]

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REPORT

ON

THE IRON AND STEEL EXHIBITS AT PARIS.

The joint resolution of Congress, approved December 15, 1877, in relation to the Universal Exposition of 1878 at Paris, provided for the appointment by the President of twenty commissioners additional to the Commissioner-General, and on the 12th day of February, 1878, I had the honor to be appointed one of these commissioners. The Exposition was opened to the public on the 1st day of May, and was closed on the 10th day of November. A large portion of the intervening time I spent at Paris or in visiting such industrial centers as would afford needed information in the preparation of this report. By arrangement with the Commissioner-General I undertook the consideration of the commercial and business aspects of the iron and steel industries as they were represented at the Exposition, and such observations as I may submit in the following pages will be strictly in accordance with this understanding, leaving to others the presentation of facts and opinions affecting the purely technical and scientific aspects of these industries. A few preliminary remarks of a general nature will, however, be permitted.

Report refers to the commercial and business aspects of the iron and steel industries.

Not to the technical.

In strong contrast with the action of our government in regard to the Philadelphia Exhibition, the French Government, rightly appreciating the benefits to be derived from international displays of industrial products, promptly resolved that the Exposition should be held, and assumed the expense of its creation and management. The people, thus encouraged and thus directed, labored with a patriotic pride and a concentration of effort worthy of all praise to secure its success. Every branch of the government and all classes of the people realized that the honor, the glory, and the welfare of France would be promoted by the Exposition, and there were therefore no serious impediments placed in its way and no jealousies engendered to cast reproach upon the French name. The Exposition was as completely successful as all France desired that it should be, and France

Prompt appreciation by the French Government of the projected Exposition.

General public interest.

Success of the Exposition.

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is richer to-day, her people are more generally employed, and her future is brighter than if it had not been held.

The part taken by France in supplying contributions to her own Exposition was such as would naturally result from the favorable conditions above mentioned; it was most creditable to her resources and to the skill of her industrial classes. With one exception, the part taken by every other progressive industrial nation which participated in the Exposition was also in the main adequate and satisfying. The United States formed the exception; neither her natural resources nor the mechanical skill and achievements of her people were adequately represented. It will be for others to state all the reasons for this inadequate display; I desire merely to add my testimony in emphasizing the fact that all the nations which made adequate displays of their products at Paris commenced to prepare their exhibits at an early day after the holding of the Exposition was determined upon. France, Great Britain, Sweden, Russia, Austria, Italy, Belgium, and the Australian colonies were in the van of preparation; only the United States, of all the leading industrial nations of the world, lagged behind. Our display, although with few exceptions excellent in quality, was not sufficient in extent, and not therefore fully representative of our varied resources. It would seem to be demonstrated by our incomplete exhibits at Vienna and Paris that we have not yet fully awakened to the importance of international industrial exhibitions. If the American people were more thoroughly in earnest in this matter the government would also be. If we would widen the area for the consumption of our agricultural and manufactured products, and if we would increase our commerce, we must not sit with folded hands and wait for customers to come to us, but swiftly as opportunity offers go in search of them. May we not learn wisdom in this matter from that mother country which has taught us so much already? At all the international exhibitions that have yet been held the products of British workshops were well represented, and upon each occasion were second only to the exhibits of the country which had invited their competition.

Good exhibits by most of the progressive nations.

The United States an exception.

Our exhibit good in quality, but inadequate in quantity and variety.

The importance to our foreign commerce of a better display of our products at international exhibitions.

British exhibits are always only second to the exhibits of the country where the exhibition is held.

Approaching the subject of the iron and steel exhibits at Paris, it is proper at the beginning to say that so complicated and expensive are the modern processes for converting iron ore into partially or wholly finished products that they are practically excluded from all international exhibitions; while, even if exhibited, they could not, for obvious reasons, be shown in operation. Other manufacturing pro-

Impossibility of illustrating modern iron and steel processes at exhibitions.

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cesses, notably such as relate to the production of textile fabrics, were freely displayed at Paris. Of the machinery connected with the manufacture of iron and steel, and the designs and models of such machinery, there was comparatively little on exhibition to suggest that marvelous mechanical and scientific progress which is well known to characterize to-day the industrial development of all iron making countries. More perhaps than any other great industry, that which embraces the manufacture of iron and steel was represented at Paris by its fruits rather than by its methods. But how numerous, and varied, and wonderful were these fruits! Of machinery used in other manufacturing industries, and made mainly or wholly of iron and steel, the display was in an economic sense the most imposing feature of the Exposition. Indeed, the presence of labor-saving machinery and its products was the great industrial base, and pillar, and crown of the Exposition, as it had been of other recent international exhibitions.

Lack of exhibits of machinery connected with the manufacture of iron and steel

Exhibits showed the fruits of the manufacture rather than the methods.

It may here be remarked that on the Continent of Europe, and to a certain extent in Great Britain, the manufacture of heavy machinery, railway rolling-stock, steam-engines, military material, etc., is more generally conducted in connection with the manufacture of iron and steel than in this country. Locomotives, railway cars, and ordnance, for instance, are not manufactured by a single establishment in the United States which makes iron and steel, but in Europe the combination of industries indicated is frequently met. Whether the economical results are satisfactory or not is simply a question of administration; but the fact is to be noted that the European system of consolidating industries has scarcely an existence in the United States. The genius of our institutions, the varied resources of our country, and its vast extent are influences which encourage individual enterprise and a separation of industries.

The manufacture of iron and steel with the manufacture of heavy machinery in the same establishment common in Europe.

COUNTRIES WHICH PRODUCE THE MOST IRON AND STEEL.

Countries which produce the most steel and iron.

The leading iron and steel producing countries of the world are as follows, in the order of their prominence:

(1) Great Britain.
(2) United States.
(3) Germany.
(4) France.
(5) Belgium.
(6) Austria-Hungary.
(7) Russia.
(8) Sweden.

These countries produce more than 98.5 per cent. of the world's annual increase of iron and steel. All were represented at the Paris Exposition except Germany. All other

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countries unitedly produce less than 1.5 per cent. of the annual increase. The iron resources of most of these countries were, however, represented at Paris. The following table of the total annual production of pig-iron and castings from furnaces and of steel is compiled from the latest statistical data accessible. The tons used are English tons, of 2,240 pounds.

Statistics of the production of pig-iron and steel.

Country.	Cast and pig iron.			Steel.		
	Year.	Production, tons of 2,240 pounds.	Per cent. of total.	Year.	Production, tons of 2,240 pounds.	Per cent. of total.
Great Britain	1878	6,300,000	45.63	1878	1,100,000	39.70
United States	1878	2,301,215	16.67	1878	735,000	26.53
Germany, including Grand Duchy of Luxemburg	1876	1,816,072	13.16	1876	384,159	13.87
France	1878	1,417,073	10.26	1878	281,801	10.17
Belgium	1876	502,086	4.07	1877	100,000	3.61
Austria-Hungary	1876	443,089	3.21	1876	113,152	4.08
Russia	1875	420,035	3.04	1875	12,720	.46
Sweden	1876	346,955	2.51	1876	23,692	.86
Other countries	1877	200,000	1.45	1877	20,000	.72
Total	.....	13,807,725	100.00	.....	2,770,524	100.00

FRANCE.

FRANCE.

Remarkable French exhibit of iron and steel.

By far the finest exhibit of iron and steel and their products ever made by France was made at her own Exposition in 1878. Her exhibit of iron and steel proper was also greatly superior in size and variety to that made at the same or at any previous international exhibition by any other country. It excited the astonishment and elicited the admiration of all who thoughtfully examined it, for few who looked upon it had before realized how largely French skill and enterprise had been enlisted in the manufacture of the more finished forms of iron and steel. In the manufacture of crude iron, castings, bar-iron, iron and steel rails, and some other heavy products, the world had known, at least since the Paris Exposition of 1867, that France was largely engaged, and that in their skillful and economical production she was not behind any other nation; but at the Exposition of 1878 she showed that in the manufacture of the most advanced forms of iron and steel and many of the products derived from them she had been enterprising and successful beyond all expectation. At Vienna, in 1873, and at Philadelphia, in 1876, France made a very poor display of her iron and steel resources and capabilities. For this the destructive war from which she had but recently emerged was doubtless the principal cause. But in 1878 she came grandly into line with other iron and steel producing nations

Great increase and improvement since 1867.

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FRANCE.

of the first rank, her steel exhibit being especially noticeable and surprising.

Of the various exhibits made by the iron and steel makers of France, that of Schneider & Co., of Creusot, was the most conspicuous and the most complete. It was closely followed by the exhibit of the Terre Noire Company, and it in turn by the exhibit of the Saint-Chamond Company. Each of these exhibits was displayed in a pavilion erected in the immediate vicinity of the main Exposition building, that of Schneider & Co. being the largest special building attached to the Exposition.

Schneider & Co., of Creusot.

Terre Noire.

Saint-Chamond.

In the Creusot exhibit the object which first attracted the visitor's attention, at the entrance to the pavilion, was the wooden model of the immense 80-ton steam-hammer finished at Creusot in 1877.* This hammer is the largest in the world, and is said to possess more than three times the power of the celebrated 50-ton Krupp hammer at Essen. A hundred-ton forging may be turned with ease upon its anvil by means of its four powerful cranes. The large sum of $500,000 is said to have been the cost of this hammer and its accessories and of the building erected for it at Creusot. Scarcely less wonderful as a metallurgical monster was the Siemens-Martin steel ingot, cast by the same company in April, 1878, and weighing 120 metrical tons, a wooden model of which was placed on exhibition. By the side of this ingot stood another wonder—a massive armor plate, 13 feet 10 inches long, 8 feet 6 inches wide, 2 feet 7 inches thick, and weighing 65 metric tons. This plate was intended for a ship's turret. Somewhat in the same line as the objects above noticed was a marine engine of 2,640 horse-power, with three upright cylinders, one of 5.49 feet and each of the others of 6.10 feet in diameter. Eight boilers were provided to supply the steam. The weight of the engine was 290 metric tons, and that of engine and boilers was 480 tons. There was also exhibited an exceptionally large cast-steel shaft for a screw-propeller, for a French naval vessel. This forging was 60 feet 4 inches long and 17 inches in diameter, and weighed 44,651 pounds, or about 20 tons. There were many other exhibits in the Creusot pavilion which indicated great facility in the manufacture of heavy machinery and warlike material for use on land or sea. There were also locomotives, iron and steel rails, plates, sheets, and wire, steel tires, iron bars, angles, and beams, and many other iron and steel products—all of good quality. A model of a modified Danks puddling machine was also exhibited,

Crousot.

Steam-hammer.

Siemens-Martin ingot.

Armor plate

Marine engine.

Screw-propeller shaft.

Danks puddler.

* See frontispiece.

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FRANCE.

with various products. This modification overcomes difficulties in machine puddling heretofore experienced in England and the United States, and it practically dephosphorizes the iron worked in it. It represents a step forward. Two of these machines are regularly at work at Creusot, giving good results, each of them producing 20 tons in 24 hours. A circular steel plate, about 90 inches in diameter, attracted attention. Models and drawings of bridges, engines, mines, workingmen's houses, etc., and of the town of Creusot itself, were liberally distributed throughout the building, as were also samples of the ores, coal, and refractory materials in use at Creusot. The whole display was most imposing, and was the finest single exhibit of iron and steel ever made at an international exhibition.

Creusot.

Models and drawings.

The finest iron and steel exhibit ever made.

The works of Schneider & Co. are mainly situated at Creusot, in the department of the Saône-et-Loire, where a Bessemer plant of 6 eight-ton converters, a Siemens-Martin plant (both commenced in 1869), blast furnaces, plate mills, gun factory, mines, etc., are located; but their locomotive, boiler, bridge-building, ship-building, and marine works are situated at the neighboring town of Châlons, on the river Saône. There are also coal and ore mines, brick works, etc., elsewhere. The ground occupied by the furnaces, rolling mills, steel works, constructing shops, and other buildings used by the company at Creusot and Châlons covers 60 acres; and the total area occupied by the works, dwellings of workmen, and railroads at the works is 1,068 acres. The number of miles of railroad operated is 188, upon which 27 locomotives and 1,518 cars are used. In all departments of the company's works there are in use 281 engines other than locomotives, 58 steam-hammers, and 1,050 steam-machine tools. In the last fiscal year there were produced 549,000 metric tons of coal, 155,000 tons of pig-iron, 126,000 tons of wrought iron and steel; and 25,000 tons of iron and steel products in the constructing shops. In the same year 400,000 tons of iron ore were consumed in 13 blast furnaces. These furnaces are from 72 to 82 feet high, and are supplied with Whitwell and Cowper fire-brick stoves and with immense blowing engines. All the Bessemer iron is run direct from the blast furnaces to the converters. In recent years the average annual production of steel rails has been 50,000 tons; of iron rails, 20,000 tons; and of locomotives 100. The total sales of the company amounted to $15,000,000 in the fiscal year 1874–'75, and to $11,600,000 in the fiscal year 1877–'78. During the past ten years the aggregate sales have amounted to $105,000,000. The company

Works at Creusot,

and at Châlons-sur-Saône.

Area occupied.

Railway and rolling-stock.

Engines and tools.

Production of iron and steel.

Production of rails and locomotives.

Sales.

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FRANCE.

employs 15,000 persons. Its nominal capital is 27,000,000 francs, or $5,211,000. The works at Creusot were founded in 1781, but they did not begin to assume any of their present importance until 1836, when they passed into the hands of Messrs. Schneider Brothers & Co.

Creusot.

The Terre Noire exhibit, although not so large as that of Creusot, was more consecutive and instructive, in showing grades of steel and the results of using metalloids. It comprised an interesting and very full collection of ores, coal, pig-iron, ferro-manganese, and spiegeleisen; bent and fractured bars; polished bars and rails; hammered, rolled, and fractured samples of various kinds of steel; cast-iron pipes of various diameters; beams, some of which were 68 feet long; galvanized iron; chains; locomotive axles; steel ingots; solid steel castings, etc. The bent and fractured specimens of iron and steel showed the quality of these metals to be excellent. There was also exhibited a model in wood of the immense blowing engine of the Bessemer plant of the company at Bességes, and a fine drawing of the large blowing engine of the blast furnaces at Tamaris; also models, drawings, and photographs of much other machinery, including photographs of the large plate train, just completed, which will roll a plate 36.08 feet long, 8.2 feet wide, and 3.9 inches thick. But the feature of the Terre Noire exhibit which attracted most attention was the display of solid steel castings, made by a process peculiar to Terre Noire, but a modification of the ordinary Siemens-Martin process. Cannon and projectiles are the principal articles made by this process, which produces a true steel free from blow-holes. The process has been briefly described to consist in the use of a silicide of manganese and iron, the silicon preventing blow-holes by decomposing the oxide of carbon which is in solution and tends to escape during solidification, while the manganese reduces the remaining silica and the oxide of iron and prevents a further production of gases by the reaction of the oxide on the carbon. About 200 tons of castings are produced monthly by this process.

Terre Noire.

Instructive consecutive exhibition.

Materials and products.

Blowing engines.

Plate train.

Solid steel castings.

Cannon, etc.

The works of the Terre Noire Company are greatly scattered, the principal branch, however, being at Terre Noire, in the department of the Saône-et-Loire. The extensive operations of the present company had their origin in the purchase of the iron mine of La Voulte, in 1810. In 1862 the erection of a Bessemer plant was commenced at Terre Noire, and in 1868 a Siemens-Martin plant was established at the same place. A Bessemer and a Siemens-Martin plant were established at Bességes in 1868. The company owns

Works of Terre Noire.

Bessemer and Siemens-Martin plant.

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FRANCE.

19 blast furnaces and all the usual appliances of an advanced and comprehensive iron and steel establishment. It has 15 Siemens-Martin furnaces, 8 Bessemer converters, 84 puddling and 55 reheating furnaces, 12 steam-hammers, and 28 roll trains for iron and steel. Its buildings cover 28 acres; it operates, with ten locomotives, 76 miles of railroad connected with its various works; and it employs 7,881 persons. Two of the Siemens-Martin furnaces have a nominal capacity of 15 tons each, and have made heats of 22 tons each.

Creusot. Plant, area, railways.

Bessemer practice at Terre Noire.

In the Bessemer practice of the Terre Noire Company spiegeleisen is melted in a Ponsard furnace, which requires 25 pounds of coal to melt 100 pounds of metal. One furnace serves four converters, but the latter, which are on the ground floor, are small and convert only 4 tons at a heat. At Terre Noire the metal is charged direct from the blast furnace into the Bessemer converter. At some of the blast furnaces of the company Siemens-Cowper stoves are used. The company is noted for its production in commercial quantities of high-grade ferro-manganese in the blast furnace. The highest it has made contains 85 per cent. of manganese, 6.7 per cent. of carbon, and 8 per cent. of iron. Ferro-manganese of from 71 to 75 per cent. of manganese is made from ores of 36 to 40 per cent. of manganese, and with about 2.75 tons of coke to the ton of product, the blast being about 715° C. An average daily production of 11 to 12 tons is obtained in a furnace which would produce 42 tons of Bessemer pig-iron in the same time. Ferro-silicium is also manufactured at Terre Noire in the blast furnace, the composition of two samples being as follows: (1) Iron, 68.50; manganese, 20; carbon, 1.50; silicium, 10. (2) Iron, 76.77; manganese, 14; carbon, 1.60; silicium, 7.50. The Siemens-Martin plant at Terre Noire is very complete and elaborate. The cost at these works of a metric ton of Siemens-Martin steel, made by the "pig and scrap" process, is given as follows: Materials used in the charge, $21.80; coal, $1.94; labor, $4.10; total, $27.84. In 1877 the Terre Noire Company produced 106,000 metric tons of coal, 200,000 tons of of iron ore, 158,000 tons of pig-iron and spiegeleisen, and 147,600 tons of cast and wrought iron and steel.

High-grade ferro-manganese.

Ferro-silicium.

Siemens-Martin plant.

Saint-Chamond.

The pavilion occupied by the enterprising company of iron and steel manufacturers at Saint-Chamond, also in the department of the Saône-et-Loire, was well filled with specimens of cannon and projectiles; railroad material and marine appliances; iron and steel beams, bars, plates, and sheets; steel tires and springs; pig-iron, spiegeleisen, iron ores, etc. The company makes a specialty of railroad and

Railway and marine work.

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FRANCE.

marine work. Several locomotives and cars and a large collection of polished and fractured iron and steel rails were exhibited; also car wheels of wrought iron with steel tires. Of the marine articles on exhibition several armor plates of great thickness were most conspicuous. Some of these were rolled much thicker at one edge than at the other, the thinner part to go under the water. The fragment of an iron armor plate thus rolled was shown, one edge of which was 14 inches thick and the other 9 inches; several indentations showed that, notwithstanding its thickness, it had been almost perforated by projectiles hurled against it. A model of the rolls by which these plates were produced was exhibited. The display of steel cannon and cast-steel cannon balls was large, the tube of one cannon weighing almost 7 metric tons. A cast-steel ingot, weighing 40 metric tons; a steel crank-axle, weighing 3½ tons; a ship's keel of wrought iron, 49 feet long, and weighing 5,170 pounds; and several large cast-steel plates for various purposes, were especially noticeable. Cast-steel beams, steel disks for circular saws, thin sheets of crucible steel, bent, twisted, and fractured bars of iron and steel, and many other specimens completed a very interesting collection of iron and steel products. Of the models shown there was one of a twenty-ton Pernot furnace in use at the works. The steel made at Saint-Chamond is made in Siemens-Martin-Pernot furnaces. Iron is also puddled in Pernot furnaces. The works produce beams, springs, tires, cannon, rails, armor and other plates, and merchant iron and steel. Steel beams are a specialty, and are made up to two feet in width by a peculiar universal train.

Saint-Chamond.

Armor plates.

Steel cannon and balls.

Steel ingots and objects.

Models of furnaces.

The company which operates the extensive works at Saint-Chamond has a capital of $2,600,000, employs from 5,000 to 6,000 workmen, and manufactures from 40,000 to 45,000 tons of iron and steel annually. Its works proper are in five divisions, and in addition it has seven blast furnaces—four cold-blast charcoal in Corsica and three hot-blast coke near Saint-Chamond.

Capital, employés, and manufactures.

In the main building of the Exposition and in the annexes there were exhibited the products of many other iron and steel establishments of France, a majority of all these establishments in the country being represented. Specimens of pig-iron and iron ores from all parts of France and adjacent sources of supply were shown.

Other French exhibits.

One of the largest armor plates at the Exposition was exhibited by Marrel Brothers; it was 13.94 feet long, 5.24 feet

Marrel Brothers.

Armor plates.

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FRANCE.

wide, 2.34 feet thick, and weighed 38 metric tons. It was made of puddled iron.

Marseilles Company.

The Marseilles Company exhibited specimens of spiegeleisen and ferro-manganese from its Saint Louis blast furnaces, and also exhibited ores from Italy, Spain, and Algeria.

Denain and Anzin Company.

The Denain and Anzin Company presented a very imposing column of iron and steel rails and other iron and steel products, including iron made in a revolving puddling furnace of the Crampton pattern.

Champagne Company.

The Champagne Company exhibited a large collection of iron ores, and of pig-iron made with both charcoal and coke.

Holtzer & Co.

Jacob Holtzer & Co. exhibited chrome pig-iron and steel, the latter showing a very fine fracture. This firm also exhibited a very large and complete assortment of steel bars of all sizes, as well as steel castings, tools, cannon, and raw materials.

Compagnie de l'Horme.

The *Compagnie de l'Horme* showed samples of wrought iron tempered in sulphuric acid to increase its tensile strength.

Coal Company of Anzin.

The Coal Company of Anzin, the largest mining company in France, exhibited a fine model of its mines, at which are employed about 15,000 persons. This company owns about 70,000 acres of land, and produces about 2,000,000 tons of coal annually.

Engines and machinery.

Engines and machinery.

Steam-engines.

The display made by France of steam-engines and locomotives was the largest in the Exposition, and showed to great advantage. Many of the engines were in motion, and in ease of movement, smoothness of finish, and adaptation to the uses to which they were applied they compared favorably with the best engines in use in the United States. I was especially pleased to see two Corliss engines of French manufacture in operation, each of about 50 horse-power. The largest engine in the Exposition building was a French engine of 700 horse-power. The display of pumping machinery was large, as was also that of machinery for the manufacture of beet sugar, which machinery we have not yet had occasion to make in our own country. In mining machinery the French department was rich, and it was apparent that in the working of coal mines especially the French had made great progress, and have probably no superiors. Of agricultural machinery the French display was exceedingly creditable. Although Great Britain and the United States each surpass France in this field of invention,

Beet-sugar machinery.

Mining machinery.

Agricultural machinery.

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FRANCE.

it must be conceded that she is rapidly adopting their best conceptions, and a field trial of competing agricultural machinery during the summer, which I witnessed, fully attested this fact. France, indeed, manifests wonderful progress in the quickness with which she perceives and the readiness with which she accepts foreign mechanical ideas. Long ago Nasmyth, the English inventor of the steam-hammer, found that Frenchmen could perceive its great advantages and possibilities when his own countrymen could not. Neilson's hot-blast, invented in Scotland in 1828, was used in France in 1832; the manufacture of Bessemer steel, invented in England in 1857, was introduced into France in 1859 at Sireuil. The Whitwell stoves are in more general use in France than in England. The most recent exhibition of this progressive mechanical spirit is, perhaps, shown in the introduction upon at least two French railroads of the Westinghouse air-brake, an American invention. In the substitution of steel for iron, now rapidly taking place in many countries, France is not behind any of her contemporaries.

Machinery.

French readiness to adopt foreign mechanical ideas.

Nasmyth.

Neilson.

Whitwell.

Westinghouse.

Tools and hardware.

Tools and hardware.

The French display of machine tools, wood-working machinery, textile machinery, gas and water pipe, general castings, cooking ranges, saws, and edge tools, and fine cutlery was in the main praiseworthy, and in some respects unsurpassed in quality, as it was unequaled in extent and variety. English exhibitors of competing articles frankly admitted the excellence of these exhibits, and with regard to some of them they also admitted that France would hereafter fully supply her own markets, and in part supply the markets of her Continental neighbors.

Iron and steel statistics.

Iron and steel statistics.

A pamphlet lies before me which contains a list of several hundred blast furnaces and iron and steel rolling mills in France. It is noticeable that more than one-half of the rolling mills are connected with blast furnaces; and it is also worthy of remark that the iron and steel industries of France are widely distributed, showing an equally wide distribution of the raw materials of manufacture and great facility in procuring those of neighboring countries. Her own large supply of native ores is supplemented by the abundant supply of foreign ores of extraordinary richness which are found near at hand in Elba, Spain, and Algeria; while Belgium and Germany may be drawn upon for ores of comparatively

Connection of rolling mills with blast furnaces.

Wide distribution of iron and steel industries.

French ores.

Ores of Elba, Spain, Belgium, and Germany.

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inferior quality. The substitution of Bessemer steel for iron has largely decreased the mining of native ores in France, and increased the use of Spanish and Mediterranean ores.

Ores of France, production, importations.

In 1877 the production of the former was about 2,000,000 tons, and the importation of the latter was 975,631 tons. In 1878 the importation was 932,284 tons. France exported 79,113 tons of ore in 1877, and 79,536 tons in 1878.

Production and consumption of coal in France.

The annual production of coal in France is about 17,000,000 tons, the annual consumption about 23,000,000 tons, and the annual exportation to neighboring countries about 800,000 tons, leaving about 7,000,000 tons to be imported. This deficiency is supplied partly from Belgium and partly from England and Westphalia. In 1876 Belgium furnished 50 per cent. of the whole importation, England 36 per cent., and Westphalia 14 per cent.

Artificial fuel.

About 700,000 tons of artificial fuel, or briquets, are annually manufactured in France from the refuse of coal mines.

Coal measures.

The production of coal in France has doubled since 1860. The coal measures are principally found in the departments of Pas-de-Calais, Nord, Loire, and Saône-et-Loire.

Production of pig-iron.

The production of pig or cast iron in France amounted to 112,500 metric tons in 1819, to 266,361 tons in 1830, to 347,773 tons in 1840, to 415,653 tons in 1850, to 898,353 tons in 1860, and to 1,260,348 tons in 1866. During the years 1874 to 1877 the production was annually about 1,400,000 tons. The exact figures for 1878 are not authoritatively published, but the approximate production for the year has been placed at

Statistics of furnaces.

1,417,073 tons, showing a slight increase. In 1861 there were 472 blast furnaces in France, of which 282 used charcoal, 113 coke, and 77 mixed charcoal and coke. In 1872 the total number of furnaces had decreased to 270, although the production of the year was much greater than that of 1861, the substitution of coke for charcoal and the use of larger and better furnaces accounting for the decrease in the whole number. Of the 270 furnaces in 1872, only 89 used charcoal, and 46 a mixed fuel; the remaining 135 used coke. The

Production of charcoal pig-iron.

annual production of charcoal pig-iron is now less than 100,000 tons. It is still customary in some parts of France to make rough castings direct from the blast furnace (classed as pig in the above statistics), and in the Pyrenees iron is still made by primitive processes.

Manufacture of iron rails in France.

The manufacture of iron rails in France began about 1840, and in 1850 the production was only 23,087 metric tons. In 1860 it was 121,348 tons, and in 1869 it was 216,628 tons. In 1872 it had fallen to 129,151 tons; in 1875 to 118,959 tons;

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in 1876 to 77,420 tons; in 1877 to 73,103 tons; and in 1878 to 53,884 tons.

Merchant iron.

The production of merchant iron (not including plates and sheets) amounted to 149,652 metric tons in 1850, and to 710,935 tons in 1872. Since 1872 this production, like that of iron rails, has decreased, the make in 1877 being 589,559 tons, and in 1878 being 608,764 tons. The production of plates and sheets amounted to 100,915 metric tons in 1865, and to 129,843 tons in 1872. The make in 1877 was 107,451 tons, and in 1878 it was 105,688 tons.

Reduced production of iron rails, etc., accounted for by the increase in production of steel.

The decrease in the production of iron rails and merchant iron and the stationary production of iron plates and sheets are results almost wholly due to the rapid increase in the manufacture of steel. In 1831 there were only 4,915 metric tons of steel of all kinds made in all France; in 1840 the production was only 8,263 tons; in 1850 it had reached to only 10,982 tons; but in 1860 it jumped to 29,849 tons; in 1872 it was 141,705 tons; and in 1878 it was 281,801 tons, of which 253,536 tons were made by the Bessemer and Siemens-Martin processes, and the remainder by various older processes. The manufacture of crucible cast steel in France does not appear to have ever much exceeded 8,000 metric tons annually, the production in 1870 being 8,135 tons, and in 1872 being 8,080 tons. Of the reported production of 253,536 tons of Bessemer and Siemens-Martin steel in 1878, the quantity rolled into rails is placed at 211,519 tons. In 1876 there were in France 26 Bessemer converters and 25 Siemens-Martin furnaces.

Statistics of steel.

Crucible cast steel.

Bessemer and Siemens-Martin steel.

Iron importation.

The imports of pig-iron into France amounted to 212,897 metric tons in 1877, and to 166,487 tons in 1878; of iron in other forms to 62,736 tons in 1877, and to 69,965 tons in 1878; and of steel to 5,009 tons in 1877, and to 6,173 tons in 1878. Against this importation France exported 169,205 tons of her iron and steel products in 1877, and 168,704 tons in 1878. France had 13,220 miles of railroad in June, 1878.

Exportation.

Railways.

In view of the present magnificent development of the iron and steel industries of France, the conclusion is fully warranted that these industries have before them a most promising future.

GREAT BRITAIN.

The exhibit at Paris by Great Britain of iron and steel and their products has been freely characterized by representative Englishmen, and representative English journals, as incomplete and unsatisfactory—not worthy of the vast

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GREAT BRITAIN.

mineral resources and still vaster metallurgical progress of their country. Taken in detail, the display of these articles may have justified this criticism; but as a whole it was extensive, varied, and exceedingly suggestive of mechanical excellence. No other nation except France made so imposing a display of steel, of cutlery, of armor plates, of stationary and other engines, of steam-pumps, and of machine tools; while its display of agricultural implements and machinery, of textile machinery, and of general hardware was the finest in the Exposition. Its entire display of machinery and tools was more than creditable—it was magnificent; and yet it must be confessed that, omitting this feature, and omitting also the splendid show of hardware and cutlery, the exhibit of iron and steel and their products by the leading nation of the world engaged in their manufacture was not such as she could have made nor such as was due to her reputation. Especially was there noticeable the absence of a large assortment of the products of the Bessemer and open-hearth processes, in the invention and perfection of which processes Great Britain is entitled to the highest honors. Such products as were exhibited were chiefly Bessemer rails and Siemens-Martin plates, and the absence of others would seem to warrant the conclusion that on the Continent and in the United States the tendency to adapt Bessemer and open-hearth steel to the manufacture of articles for which other steel and iron have heretofore been required is stronger than in Great Britain. This view would, however, be erroneous. Great Britain failed to make a complete display of the capabilities of Bessemer and open-hearth steel; but she has not, therefore, confessed that she has failed to observe and to utilize them. On the contrary, there is abundant evidence, to be noted further on in this report, that she is abreast of other nations in adapting Bessemer and open-hearth steel to miscellaneous uses.

Excellent display of steel, steel products, engines and machine tools.

Hardware and cutlery.

Bessemer rails and Siemens-Martin plates.

Exhibits of steel.

Steel exhibits.

Of the display of Bessemer steel in the British section the prominent firm of Bolckow, Vaughan, & Co., of Middlesborough, contributed finished products in various forms, but principally rails from their steel works at Eston, which were established in 1877, have four eight-ton converters, and can produce 2,000 tons of rails weekly. They also contributed complete samples of the raw materials used at their works, the ore coming from the west coast of England and from Bilbao, in Spain.

Bolckow, Vaughan, & Co.

Rails and raw materials.

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GREAT BRITAIN

Brown, Bayley, & Dixon.

The well-known firm of Brown, Bayley, & Dixon, of Sheffield, made a fine display of Bessemer rails, tires, axles, bars, etc. They exhibited a rail 130 feet long, rolled direct from the ingot, and bent into four lengths of 32 feet each, the whole measuring 4½ feet across. Among the tires exhibited by this firm were two of 9 feet in diameter, one polished and the other unpolished. Their locomotive springs were very fine, as were their large and small chains.

Rails, tires, and springs.

John Brown & Co. Charles Cammell & Co. Plates, rails, and axles.

The celebrated steel-making firms of John Brown & Co. and Charles Cammell & Co., of Sheffield, also exhibited samples of their Bessemer rails, axles, etc. Steel armor plates formed an impressive feature of their exhibits.

West Cumberland Iron and Steel Company. Boiler plates.

A Bessemer steel boiler-plate, of superb quality, which had been subjected to a test of the utmost severity, was exhibited by the West Cumberland Iron & Steel Company.

Landore Company. Dr. Siemens.

Of Siemens steel, made by the "ore" process, the only noticeable display was made by the Landore Company, of which Dr. Siemens himself is the head. The exhibit of this company, in an annex to the main building, embraced specimens of rolled and forged steel in various minor forms; also heavy ship plates of the same material; also rails, angles, beams, tires, and axles. The exhibit was scarcely such in location, style, and variety of samples as might have been expected from this company.

Ship plates, rails, beams, tires, and axles.

Whitworth metal.

One of the most interesting of the British steel exhibits was that which embraced various samples of the "Whitworth metal," to which much importance has been attached in Great Britain in connection with the manufacture of ordnance and other articles by the Siemens and Siemens-Martin processes. The exhibit was large, and of a character to favorably impress the visitor. The metal is made of more than ordinary solidity and tenacity by being cast under hydraulic pressure. Cannon and shells of this metal are said to withstand the severest tests, a claim that received confirmation from some of the samples submitted. A propeller shaft was exhibited, forged hollow, which it was claimed was much stronger than a solid wrought-iron shaft of the same size, which would weigh one-half more. This shaft, forged from a hoop of compressed steel, was 33 feet 7 inches long, the outside diameter 17½ inches, and the diameter of the bore 11⅜ inches. A hydraulic cylinder of this metal was shown which was represented to stand a pressure of four tons to the square inch. For machine tools, in which strength combined with lightness is desirable, the compressed steel is claimed to have no equal. Sir Joseph Whitworth's aim has been to produce a steel that would be free from blow-holes, and this result

Hydraulic pressure steel casting.

Hollow propeller shaft.

Value of the compressed steel.

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GREAT BRITAIN.

he has accomplished by mechanical means. It has already been stated in this report that a similar result has been claimed by the Terre Noire Company, in France, through chemical combinations.

Process of Terre Noire Company.

Hadfield's Steel Foundry Company.

Hadfield's Steel Foundry Company, of Sheffield, exhibited crucible steel castings, in various forms, principally, however, as railroad appliances, including very light wheels for street railroads. The wearing qualities of these wheels are doubtless excellent, but they are hardly superior in this respect to American chilled cast-iron wheels, while they are much more expensive. Their extreme lightness, however, is a recommendation, although it may be doubted whether they are much, if any, lighter than the best cast-iron wheels on American street railroads.

Street railway wheels.

Attwood's steel.

Steel wheels of various sizes, from colliery sheaves to car wheels, made from Attwood's steel, at the Stanner's Close Steel Works, at Wolsingham, were also exhibited, as were other steel castings and steel forgings from the same works.

Guy & Co., tool steel.

The exhibit made by the cast-steel makers of Sheffield was not large, but it was interesting and valuable. Tool steel was shown in great variety by Guy & Co.

Jowitt & Sons, circular saws.

Jowitt & Sons showed circular saws with perforated teeth; one of the saws was 7 feet and 3 inches in diameter.

Siebohm & Dieckstahl.

Siebohm & Dieckstahl exhibited many fine steel fractures, showing their steel to be of exceptional excellence; other firms showed cast steel in various forms and tools made from it.

Andrew & Co., wire.

Andrew & Co., of the Toledo Works, showed a piece of cast-steel wire rod, No. 2 wire gauge, 1,250 feet long.

Thomas Turton & Sons' springs.

Thomas Turton & Sons made a fine display of cast-steel springs.

William Jessop & Sons.

The most extensive of the Sheffield cast-steel exhibits was that of William Jessop & Sons, who exhibited a full assortment of their products, a leading feature of which was a steel disk or saw plate, 10 feet 8 inches in diameter, $\frac{9}{16}$ of an inch thick, and weighing 2,688 pounds. This firm also exhibited a block of best cast steel, 20 inches square, and weighing 1 ton and 10 cwts.; also other ingots of large size, broken and showing fine fractures; also specimens of crucible steel boiler plate, bent, twisted, and punched cold.

Saws, ingots, plates.

A few cast-steel manufacturers at Newcastle-on-Tyne and elsewhere also exhibited their products.

Tools and cutlery.

Sheffield made a good display of cutlery, saws, and edge, tools, and this was supplemented by like contributions from

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other British manufacturing centers; but the whole British exhibit of these articles was inferior in extent to that of France, and, in some respects, was fully equaled by it in quality. The French saws at the Exposition were especially noticeable and excellent.

GREAT BRITAIN.

Saws.

Iron products.

Iron products.

Of iron products proper and the raw materials of their manufacture the best display in the British section was made by the Cleveland and North of England district. The iron-masters of this district showed commendable enterprise in the extent, variety, and neatness of their display. They exhibited the exact quantity of coke, ore, and limestone used in the production of one ton of Cleveland pig-iron, namely, a pillar of native iron ore 10 feet high and weighing $3\frac{4}{5}$ tons, 24 cwts. of Durham coke, and 12 cwts. of Weardale limestone. Various samples of pig-iron, castings, wrought-iron tubes, plates, sheets, rails, girders, etc., were also shown. The castings exhibited by the proprietors of the Acklam Works, at Middlesborough, including garden chairs, umbrella stands, and similar light wares, were cast directly from the blast furnace, the better to show the quality of the Cleveland metal for foundry purposes. Mr. I. Lowthian Bell, M. P., exhibited samples of Cleveland iron from which the large percentage of phosphorus originally contained in it (1.2 to 1.75) had been almost entirely removed by his oxide of iron process. He also exhibited samples of steel made from this iron. Specimens were also shown by Hopkins, Gilkes, & Co., of Middlesborough, of iron made in the Danks puddling furnace from Cleveland pig-iron. They fully established the claim for excellence that has been made for this iron, and it was not surprising to learn that it is competing with the best Staffordshire brands. It possesses a tough fiber and great tensile strength. Siemens-Martin steel made from this iron was also exhibited. The Danks furnace has been proved to be a powerful agency in the elimination of phosphorus from Cleveland pig-iron, but, although successfully competing in quality and price in the manufacture of the very best bar-iron, the proprietors cannot, by its instrumentality, make iron rails of sufficient hardness to compete with Bessemer rails in wearing qualities.

Cleveland and North of England district.

Samples of iron-work.

Acklam Works.

I. Lowthian Bell.

Hopkins, Gilkes & Co.

Danks furnace.

The Cleveland and North of England district is the most productive iron district in the world. It embraces less than three English counties—Northumberland, Durham, and the North Riding of Yorkshire—and yet its annual production of pig-iron during the years 1871 to 1878, both inclusive,

Immense production of the Cleveland and North of England district.

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GREAT BRITAIN.

Cleveland and North of England district.

averaged over 2,000,000 English tons. In each of these years it produced more pig-iron than any other country, the United States alone excepted, and in the years 1875, 1876, and 1877 it produced more than the United States, the exact figures for 1877 being as follows: Cleveland, 2,138,378 tons; United States, 2,066,594 tons. In 1878 the production of Cleveland declined to 2,023,177 tons, which was less than that of the United States in the same year. There are 165

Blast furnaces.

blast furnaces in this district, some of them being the largest in the world. Of these, 92 were in blast and 73 were out of blast in December, 1878. In 1840 the number of blast furnaces was less than a dozen, and they were all small. The district produces about one-third of the total pig-iron product of Great Britain It also produces over

Coal.

31,000,000 tons of coal annually, or about 23 per cent. of the immense coal product of the kingdom. Until a year or two ago it was also very prominent in the manufacture of

Puddling furnaces.

finished iron. Of 7,159 puddling furnaces in all Great Britain, 1,894 are to be found in this district. The extreme cheapness with which Cleveland pig-iron can be made brings it into successful competition with the pig-iron of Scotland and other districts of Great Britain, and with that of Belgium, Germany, and other Continental countries. The fact is to be noted, however, that, notwithstanding this cheapness and the rapid growth of the Cleveland iron district in

Exports of pig-iron.

the last ten years, the exports of pig-iron from all Great Britain since 1873 have annually been less than in 1871, showing that Cleveland pig-iron is merely taking the place in foreign markets of other British pig-iron, particularly that of Scotland.

South Staffordshire district.

The district of South Staffordshire is the great center of the finished iron trade of England. It contains 125 separate and distinct iron works, or, as we say in our country, roll-

Rolling mills and puddling furnaces.

ing mills, having over 2,000 puddling furnaces, out of a total of 7,159 in the whole of Great Britain. It also contains 148

Blast furnaces.

blast furnaces out of a total of 977 in the kingdom. Of the whole number in the district only 38 were in blast in December, 1878. But of the large iron interests packed in this small territory very little display was made at Paris. Several firms exhibited specimens of sheet-iron, some of which were bent into various shapes to show their excellent quality.

North Staffordshire and Shropshire.

Earl Granville, of North Staffordshire, and the Lilleshall Company, of Shropshire, showed samples of their iron ore, coal, and pig-iron.

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GREAT BRITAIN.

The Snedshill Iron Company, of Shropshire, made a fine display of boiler plates, rods, bars, etc. Snedshill Iron Company.

The Shelton Bar-Iron Company, of North Staffordshire, showed fine samples of its rails, angles, tees, girders, plates, etc. Shelton Bar-Iron Company.

The North Lonsdale Iron and Steel Company, and the firm of Harrison, Ainslie, & Co., both of Lancashire, showed samples of their pig-iron and raw materials. North Lonsdale Iron and Steel Company.

The Leeds Forge Company, of Leeds, Yorkshire, exhibited in a small case samples of excellent boiler plate, folded sixteen times without cracking; also shafts and locomotive axles of superior quality. This company also exhibited Fox's patent corrugated flue for steam-boilers, the invention of Mr. Sampson Fox, the managing director of the company. This flue is made from best Yorkshire cold-blast pig-iron, and the following advantages are claimed for it: "Increased strength against collapse; much thinner plate than usual may be used and higher pressure adopted with increased safety; increased heating surface; a more effective heating surface—due to flame impinging on corrugated surfaces; more elasticity longitudinally compared with a plain flue; and increased circulating action of the water—due to steam being formed in the annular grooves or corrugations." Leeds Forge Company. Boilers, shafts, and axles. Corrugated flues.

W. B. Wright & Co., of Bristol, exhibited specimens of their galvanized sheet-iron, including a sheet 16 feet long, with eight 3-inch corrugations, and of 24 Birmingham wire guage, claimed to be the largest sheet of the kind ever rolled. W. B. Wright & Co., galvanized sheet-iron.

Other specimens of galvanized iron sheets were exhibited in the British section; also tin and terne plates, galvanized and other wire, and a long list of minor iron and steel products. Tin and terne plates. Wire.

The iron and steel industries of Scotland and Wales were very meagerly represented. In Scotland there are 22 rolling mills, 345 puddling furnaces, and 155 blast furnaces. In all Wales and Monmouthshire there are over 20 rolling mills, over 800 puddling furnaces, and 174 blast furnaces. The great iron ship-building firms on the Clyde, the Tyne, and the Thames made no sign. Of iron bridges, or the parts composing them, there was no display worthy of special mention. Of the excellent coal and coke of the United Kingdom the display was ample. Iron and steel industries of Scotland and Wales. Ship-building firms not represented.

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GREAT BRITAIN.

Machinery, etc.

Machinery.

But what Great Britain lacked in iron and steel exhibits she made up in all kinds of machinery. Her display of agricultural machinery was very large, the best she ever made, but its merits were stoutly contested by French and American exhibitors. Of mowers, reapers, thrashers, cultivators, plows, and the long line of agricultural machines and implements now regarded as essential to progressive agriculture, the British section contained a large and excellent assortment. A prominent feature of the British agricultural machinery exhibit was the steam-plow, which has not yet been brought into use in either France or America, except experimentally, although largely employed in England. The introduction of this great labor-saving machine upon our Western prairies may be presumed to be among the possibilities of the near future, as may also the introduction upon American farms of another feature of European agriculture, the beet sugar industry. In the British section there was a display of stationary, portable, locomotive, fire, and marine engines that was almost bewildering in its extent and variety. Galloway & Son, of Manchester, exhibited a 300-horse-power engine which attracted much attention. It had two cylinders, one high and the other low pressure. The workmanship was excellent. Of steam-pumps, hydraulic cranes, and other hydraulic machinery, portable forges, steam-hammers, wood-working machinery, and machine tools generally, the display was also large. Two steam-cranes, exhibited by Messrs. Appleby Brothers, deserve special mention. The exhibit of textile machinery was magnificent and unequaled.

Admirable exhibit.

Agricultural machines.

Steam-plows.

Beet-sugar industry.

Steam-engines.

Galloway & Son.

Hydraulic machinery.

Machine tools.

Appleby Brothers.

Steam-cranes.

Textile machinery.

It has already been remarked that in the nature of things it is impossible to exhibit at an international exhibition many of the processes of iron and steel manufacture. In the British section there was, therefore, but little to suggest the methods by which the greatest iron and steel producing country in the world has attained its pre-eminence. A model and drawings of the Whitwell stoves were exhibited by the Messrs. Whitwell.

Whitwell stoves.

Messrs. Brown, Bayley, & Dixon exhibited a design of Cooper's patent appliance for utilizing the heat from Bessemer converters, by carrying the flame through a stack or chimney into a stove containing a series of pipes, through which the blast for melting pig-iron is forced.

Brown, Bayley, & Dixon.

Cooper's hot-blast apparatus.

Charles Wood.

Furnace slag.

Charles Wood, of Middlesborough, exhibited models of his machine for the utilization of blast-furnace slag.

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GREAT BRITAIN.

Francis H. Lloyd.

Francis H. Lloyd, of Wednesbury, showed samples of his patent open spray tweers for blast furnaces.

Prof. Barff.

Professor Barff exhibited specimens of wrought iron made impervious to rust by his coating of black oxide.

Charles Wood.

P. & W. MacLellan. Railway sleepers.

In exhibits of new or curious uses for iron and steel the patent iron railway sleeper of Charles Wood, and the patent elastic embossed railway sleeper of P. & W. MacLellan, of Glasgow, may be mentioned. The superiority of wire over hempen rope for ship's cables and ship's rigging was shown in the exhibit of a wire rope by the side of a hempen one of double the size, but of less strength.

Wire rope.

Car wheels.

Railway car wheels with wooden and others with paper centers were shown; the latter are not much in use in Great Britain, or in any part of Europe, but the former are extensively used on the London, Brighton and South Coast Railroad.

Galvanized water-pipes.

Another noticeable exhibit was that of iron water-pipes galvanized upon the inside.

Tin.

Tin.

Tin-plate manufacture scarcely exists in the United States.

The British display of tin and terne plates and their products was, as might have been expected, large and creditable. As the manufacture of these plates is strictly a branch of the iron industry, and a very extensive branch of the British iron industry, the fact may here be noted that it has scarcely an existence in the United States, the second in rank among iron-producing countries.

Steel constructions.

Steel constructions.

Steel in ship-construction.

The adaptation of steel to ship-building was not shown in the British section by the presentation of comparative or other tests made by the British admiralty or the British Lloyd's, although experiments on a large scale, favorable to steel, had been made by both these agencies prior to the opening of the Exposition. These experiments related to the plating of the hulls of vessels and the general substitution in their frame-work and interior construction of steel where iron is now used. As these and earlier experiments have already resulted in the building of two steel vessels for the British Government and in contracts for the building of other vessels, it is to be regretted that no record was made at Paris of the reasons that have prompted action which may lead to a revolution in the construction of both naval and merchant vessels.

Steel in bridge building.

Nor were the bridge-building qualities of steel fully illustrated at Paris by Great Britain, although her engineers have made numerous experiments in its use for this purpose. A monograph, prepared by W.

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GREAT BRITAIN.

W. Parker. Parker, esq., chief engineer-surveyor of Lloyd's Register, showing the use which has been made of steel for marine boilers, was circulated at the Exposition.

Progress in utilization of steel. Great Britain is making great progress in the utilization of steel for all purposes to which it is adapted, the preference being for Bessemer and Siemens-Martin steel because of their cheapness. Steel boilers for stationary and locomotive engines are largely manufactured. Steel car wheels have already been mentioned. The Sheffield cutlers have commenced to use Bessemer steel in the manufacture of scissors and other cutlery. In some instances steel rail ends are used for this purpose, and in others steel of a desired quality is specially manufactured. In all railway appliances steel made by the Bessemer and the Siemens-Martin processes is rapidly displacing iron in Great Britain, as it is on the Continent. Iron, however, has found new friends in those inventors who have suggested its use in the construction of the so-called permanent way of railroads, and various systems of this new permanent way are now in daily use on the Continent. In Great Britain one or two of them have been used experimentally, and a commencement has been made in shipping iron for the construction of the permanent way of an Indian railroad.

Boilers.

Car wheels.

Bessemer steel for cutlery.

Iron for permanent way of railways.

Iron, steel, and coal statistics.

Iron, steel, and coal statistics.

The story of Great Britain's wonderful achievements in the manufacture of iron and steel is best told in the statistics of their production; and, in this connection, the statistics of her coal production should not be overlooked, for it is to the existence of her immense coal deposits that her prominence in the manufacture of iron and steel is mainly due. In 1735, one hundred and forty-four years ago, the total make of pig-iron in Great Britain was only 17,000 English tons. In 1854, the epoch of the Crimean war, a quarter of a century ago, it had steadily increased to 3,069,838 tons, and in 1871, seventeen years after 1854, this product was more than doubled, the production in that year being 6,627,179 tons. In 1872 there was an increase to 6,741,929 tons, the highest product yet attained. In 1877 the production was 6,608,664 tons, which was somewhat less than that of 1871. To fully realize the magnitude of these figures, comparison of them should be made with the figures representing the world's total production of pig-iron in 1877. This total production was a fraction less than 14,000,000 tons; the production of pig-iron by Great Britain in that year was, therefore, almost one-half of that total

Make of iron in 1735.

In 1854.

In 1871.

In 1872.

In 1877.

World's production of pig-iron in 1877.

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GREAT BRITAIN.

But Great Britain's progress in the manufacture of steel has been much more rapid than the development of her pig-iron industry. At the period of the Crimean war her annual production of all kinds of steel was only about 50,000 tons, but immediately after the close of that war the Bessemer process was invented, and in 1878 no less than 850,000 tons of steel were made by it alone in Great Britain. In 1856 Dr. C. W. Siemens and his brother Frederick invented the Siemens regenerative gas furnace, and in 1864 it was successfully applied to the production of steel by the Martin process. In 1878 there were produced in Great Britain by the Siemens-Martin process and its near relative, the Siemens process, 174,000 tons of steel. The total production of steel in Great Britain in 1878 is supposed to have been 1,100,000 tons, which was nearly 40 per cent. of the world's production of about 2,700,000 tons in that year.

Steel manufacture. In 1854.

Production by Bessemer process in 1878.

Siemens Brothers.

Regenerative furnace.

Production by Siemens-Martin process in 1878.

British production of steel in 1878.

World's production.

In producing her enormous annual yield of pig-iron Great Britain has mainly relied upon her own supplies of iron ore. In 1877 she mined 16,692,802 tons of ore, and imported 1,142,308 tons, principally from Spain and Algeria, for use in her Bessemer steel works. In the same year she extracted 415,000 tons of "burnt ore" from imported cupreous pyrites, principally obtained in Spain. She thus smelted in 1877 a total of 18,250,110 tons of iron ore, from which were obtained 6,608,664 tons of pig-iron. Only two districts in Great Britain—Northwest Lancashire and Cumberland—can supply large quantities of ore suitable for Bessemer steel. The importation of foreign ores for Bessemer purposes is absolutely necessary.

British ore mined.

Foreign ores.

Necessary for Bessemer process.

The production of coal in Great Britain, keeping pace with that of pig-iron, has more than doubled since the period of the Crimean war. In 1854 it was 64,661,401 tons, and in 1875, twenty-one years afterwards, it was 131,867,105 tons. This product was increased in the following year to 134,125,166 tons, and in 1877 it was further increased to 134,610,763 tons. The world's production of coal in 1877 has been placed at about 285,000,000 tons; so that Great Britain produces almost one-half of this product. It is stated that the largest coal field in England, with the greatest quantity of unworked coal, is the Midland, which extends from the town of Nottingham to Leeds, and is nearly 70 miles in length.

British coal production.

In 1854.

In 1875.

In 1877.

World's production of coal in 1877.

Midland coal field.

In the building of iron steam and sailing vessels Great Britain undoubtedly leads all other countries combined.

Iron vessels.

The immense quantities of iron and steel and their manufactured products which are annually exported from Great

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GREAT BRITAIN.

Britain to other countries will be seen in the following summary. In 1872 the maximum of yearly exports of iron and steel and their manufactures was attained, when a total of 3,382,762 tons was exported. From 1872 to 1876 the exportation of these products gradually declined in quantity to 2,224,470 tons; but in 1877 a slight increase to 2,344,651 tons took place, which was, however, not maintained in 1878, when 2,299,223 tons were exported. The value of British iron and steel exports has steadily declined from £37,731,239 in 1873 to £18,393,974 in 1878.

British iron and steel manufactures.

Value of exports, 1873–1878.

Coal exportation.

The exportation of coal and coke from Great Britain to other countries gradually increased in late years until 1876, when a maximum exportation of 16,299,077 tons was attained. In 1877 the quantity sent abroad fell to 15,358,828 tons. In 1860 the exports amounted to 7,412,000. This quantity was more than doubled in 1876. About one-third of the total British production of coal is used in the home iron and steel industries.

Importation of iron and steel.

The importation of iron and steel into Great Britain is annually increasing. The value of the importations in 1877 reached £1,943,622. The imports of coal into Great Britain are so small as not to justify the quotation of exact figures.

Railways.

There were 17,109 miles of railroad in Great Britain at the beginning of 1878.

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Statistics establish the fact that Germany is entitled to a place in the front rank of iron and steel producing countries, but none of her industries were represented at the Paris Exposition, and nothing could therefore be learned within its gates of the characteristics and present condition of her iron and steel manufactures. It would not be proper, however, if any mention of these were entirely omitted from this report, and I accordingly present below such information concerning them as could be gleaned by personal observation and by reference to official or other reputable publications.

Not represented at the Exposition.

Since the war with France and the acquisition of Alsace and Lorraine, the German Empire, including for the purposes of this report the Grand Duchy of Luxemburg, has greatly increased its annual production of iron and steel, the payment of the large French indemnity serving to stimulate all German industries, and Alsace and Lorraine contributing about 20 blast furnaces and several large rolling mills, steel works, and founderies. But Germany had made great progress in the development of her iron resources prior to the

Increased production of iron and steel.

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GERMANY.

war with France. She had shared the general activity caused by the ushering in of the age of steam and the age of railroads, each of which created a greatly increased demand for iron and its products. In 1830 Germany produced only about 100,000 metric tons of pig-iron, and it was not until 1848 that this quantity was doubled, when 205,342 tons were produced. In 1862 the production reached 524,591 tons, which was more than doubled six years later, in 1868, when 1,200,188 tons were produced. In 1869, the year preceding the beginning of the war with France, the production was 1,356,965 tons. In 1870 and 1871 it was practically stationary, but in 1872, after the accession of the French provinces, it jumped to 1,927,061 tons, and in 1873 it reached a maximum of 2,174,058 tons; adding castings from the blast furnace, the production in the last year was 2,240,575 tons. The production of pig-iron declined from 1873 to 1876, in which latter year it was 1,801,457 tons; including 44,888 tons of castings from the blast furnace, it was 1,846,345 tons. These statistics show more rapid progress in the building up of the German iron industry than has been made in the United States. In 1848 the latter country produced about 800,000 English tons of pig-iron; and in 1873 a maximum of 2,560,962 tons was reached. The increase of production in the United States from 1848 to 1873 (from 800,000 to 2,560,962 tons) was at a ratio more than trebled by Germany in the same period (205,342 to 2,240,575 tons). As Germany has usually imported more pig-iron than she has exported, and as the accession of Alsace and Lorraine gave to her only about 230,000 tons of pig-iron annually, the greater progress of Germany from 1848 to 1873, as compared with the progress of the United States, is an interesting fact, and is creditable to the enterprise and skill of the German people and to the natural resources of the empire.

Iron production in 1830.

In 1848.

In 1862.

In 1872.

In 1877.

Rapid progress.

Production in United States in 1848 and 1873.

Greater relative increase in Germany.

The growth of the pig-iron branch of the German iron trade down to 1873 was fully equaled in rapidity by other branches of iron manufacture and by the manufacture of steel. In 1848 there were within the limits of the present empire 109 foundries for iron castings, employing 5,112 workmen, and in 1875 the number had increased to 874, employing 42,134 workmen. The production of these foundries increased from 131,929 metric tons in 1862 to 524,137 tons in 1873, but declined to 436,104 tons in 1876. The quantity of steel of all kinds produced in 1848 was 9,024 metric tons; in 1862 it was 40,916 tons; in 1876, when the maximum was attained, it was 396,434 tons. The total production of the foundries, rolling mills, and steel works

Iron and steel manufactures.

Foundries in 1848.

Production of iron castings.

Production of steel.

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of Germany was 205,133 metric tons in 1848; 1,076,476 tons in 1868; 2,054,980 tons in 1874; and 1,835,224 tons in 1876.

Production of iron and steel works.

Production of ore.

The production of iron ore in Germany in 1848 was 693,725 tons; in 1873 it was 6,177,576 tons; and in 1875 it was 4,730,553 tons.

Coal and lignite.

The production of coal and lignite in Germany was 5,800,985 metric tons in 1848, and 49,550,462 tons in 1876. The highest recorded production of the United States was 47,513,235 English tons in 1875. Of the total production of mineral fuel by Germany in 1876, there were 38,454,428 tons of bituminous coal and 11,096,034 tons of lignite.

Relative rank of Germany in the production of iron and coal.

The foregoing statistics show that the German iron, steel, and coal industries have been almost wholly developed during the past thirty years, and that the iron industry proper reached the culmination of its prosperity in 1873. Germany is to-day the third in rank among iron-making and steel-making nations, Great Britain and the United States alone outranking her, while she probably ranks next to Great Britain as a coal-producing country.

Ores and coal.

Ores and coal.

A study of the resources possessed by Germany for the manufacture of iron and steel shows that they are both extensive and varied. Iron ore and coal are abundant, and the quality of each favorably compares with that of like products of Great Britain and France. The coal, which is easily mined, is equal to English and Welsh coal for generating steam, and the most of it yields good coke for the blast furnace. It is superior to that of France. The French people deserve great credit for producing good iron with poor coal. The ore is of all varieties, and no difficulty is experienced in working it, except that which is caused by the presence of too much phosphorus in some varieties, rendering them unsuitable for Bessemer steel. There are commercial difficulties, however, which consist in the general separation of the coal and ore supplies, and in the remoteness of both from centers of consumption and from the seacoast. The coal deposits are found mainly in Silesia and Saxony, bordering on Austria, and in Westphalia and Rhenish Prussia, bordering on Holland and Belgium. The ore mines are found in the same provinces and in others lying mainly upon the interior boundary line of Germany, including Bavaria, Würtemberg, Alsace, Lorraine, and Luxemburg; but wherever found they are not usually associated with the coal deposits. Railroad and canal transportation,

Abundant.

Quality of coal; actual and relative.

Quality of ores.

Relative position of coal and ore deposits.

Coal.

Ores.

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GERMANY.

at greater or less expense, is thus rendered necessary to bring the raw materials together in the blast furnace and to carry pig-iron to founderies and rolling mills. But the location of the coal and iron ore at points remote from the sea-coast, and from each other, results in a still greater disadvantage to both the coal and iron industries of Germany, by making them, in a very large degree, the prey of foreign competition, water transportation for British coal and iron being much cheaper to German seaports and to cities upon navigable rivers which flow into the North Sea or the Baltic Sea than railroad or canal transportation to the same markets for the products of German mines and iron works. For the same reason these products are largely debarred from foreign markets into which they would otherwise find a ready entrance; and, for the same reason, also, the cost of foreign ores for most of the Bessemer establishments of Germany, which are in the interior, is greatly increased beyond the cost of similar ores to British Bessemer steel manufacturers. The German iron trade at present labors under still another difficulty, in the removal, on the 1st of January, 1877, of all import duties on iron and steel. The government is, however, giving close attention to the needs of the iron and coal industries. The use of native coal by the German navy is encouraged; the cheapening of inland transportation and the increase of transportation facilities are also encouraged; and the re-imposition of duties on foreign iron and steel is certain to be decreed at an early day.

Coal and ore deposits.

Difficulties and expense of transportation.

Removal of German import duties on iron and steel.

Probable re-imposition.

Furnaces.

Furnaces.

The number of blast furnaces in Germany in 1876 was 463, of which 297 were in blast and 166 were out of blast. Of the whole number of furnaces 338 were in Prussia, and of these 172 were in blast. The consumption of raw materials in the production of a ton of pig-iron in Germany ranges from 2.5 to 2.8 tons of ore, from 2.8 to 3.2 tons of coal or coke, and from 1 to 1.5 tons of limestone. Many of the furnaces of Germany possess all the approved modern appliances, while comparatively few are wholly antiquated in style and naked in equipment. At Hof, in Bavaria, there are four furnaces owned by one company, each of which is 57½ feet high, 19 feet in diameter, and supplied with four Whitwell stoves. In 1874 two furnaces, 61 feet high, and having jointly a daily capacity of 70 to 80 tons, were put in blast at Mezieres-le-Metz, in Alsace. These furnaces were provided with all modern improvements, and have Cowper-

Statistics of blast furnaces.

Hof, in Bavaria.

Mezieres-le Metz, in Alsace.

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Siemens hot-air stoves. Two out of four furnaces of Berge-Borbeck, belonging to the Phœnix Company at Laar, produced 27,982 tons of pig-iron in 1875, or a daily average of 76⅔ tons. To produce this quantity of pig-iron there were required 59,575½ tons of ore, 39,151 tons of coke, and 27,365 tons of limestone. Better results than these have been obtained at other furnaces in Germany, but the above figures I find to have been deemed worthy of prominent mention. There is observable a vast amount of enterprise and skill in the management of the blast furnaces of Germany. One of the coke furnaces of the Hoerde Iron Works was continuously in blast from July 3, 1855, to May 29, 1874, or almost nineteen years. German rolling mills and steel works are also mainly projected on a liberal and progressive scale. Krupp's Steel Works, at Essen, in Rhenish Prussia, are well known to be the largest in the world. A recent publication enumerates 16 German iron and steel companies, each of which had either absorbed over 4,000,000 marks, or $1,000,000, or had been organized with a capital stock of this amount. One of these, the König and Laura Hütte, had a capital of 27,000,000 marks, or $6,750,000; another, the Dortmund Union, 41,400,000 marks, or over $10,000,000; another, the Donersmarkhütte, 18,000,000 marks, or $4,500,000; another, the Phœnix, 16,200,000 marks, or $4,000,000; two others, the Hoerde and the Bochumer Verein, had 15,000,000 marks each, or $3,750,000; and yet two others, the Preussische Company of Dusseldorf and the Westphälische Union, had over 10,000,000 marks each, or over $2,500,000. These references show the large, not to say extravagant, scale on which many of the iron and steel works of Germany have been projected.

Phœnix Company.

Proportions of ore, coke, and limestone in the production of pig-iron.

Hoerde Iron Works.

Krupp's Steel Works.

Capital invested in:

König and Laura Hütte.

Dortmund Union.

Donersmarkhütte.

Phœnix.

Hoerde.

Bochumer Verein.

Preussische Company.

Westphälische Union.

Steel production.

Steel production.

Germany early embarked a large amount of capital in the manufacture of Bessemer steel, although from the first the unwelcome fact was only too manifest that most of the ore suitable for its production would have to be imported, at least for some time. This disadvantage is now, however, not so great as formerly, domestic ores being mixed to a larger extent with foreign ores in the manufacture of Bessemer pig. The first Bessemer steel works in Germany were built about 1865, and in 1876 there were no less than 19 such establishments. Of these, 14 were in Prussia, 1 in Saxony, 2 in Bavaria, and 2 in Alsace and Lorraine. These 19 establishments contained 78 converters, of which 18 were embraced in Herr Krupp's works at Essen. Three additional con-

Bessemer steel Works.

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verters, or a total of 81, were enumerated in 1877. Only 39 converters were at work in that year, and some of them not steadily. In apparent contradiction of the praise just bestowed on the iron and steel metallurgy of Germany, figures have been produced to show that the average yield of German converters when at work is only between one-third and one-fourth that of converters in the United States. This is certainly not a creditable showing for Germany, but it may be said in extenuation that the Bessemer practice of the United States is not equaled by that of any other country in the world. Even Great Britain falls far behind it. With 114 converters, a majority of which may be presumed to have been active, that country produced in 1878 only 850,000 tons of ingots; while the United States in the same year, with 22 converters, not all of which were active, produced exactly 653,773 English tons of ingots. Germany has made creditable progress in the introduction of the Siemens regenerative furnace and the Siemens-Martin process.

Bessemer practice in Germany.

Superior Bessemer practice in the United States.

Comparative production per converter of England and of the United States.

The total production of all kinds of steel in Germany has already been given for comparative years, the production for 1876 being 390,434 metrical tons. The exact quantity of each kind of steel which entered into this total is not at hand, but the proportion of Bessemer steel, as well as the extent to which it is displacing iron in Germany, may be inferred from the following statistics of the production of iron and steel rails in the years 1871 to 1876:

Total production of steel in Germany, in 1876.

Statistics of steel production.

Year.	Iron rails.	Steel rails.	Total.
	Metric tons.	*Metric tons.*	*Metric tons.*
1871	320,619	128,406	449,025
1872	320,996	179,092	500,088
1873	385,601	186,643	572,244
1874	364,978	237,894	602,872
1875	227,976	241,505	469,481
1876	126,288	253,746	380,034

To illustrate the value of the accession to German iron resources and manufactures resulting from the acquisition of Alsace and Lorraine, the following statistics relating to their largest iron-making establishment are given as I find them in a foreign journal. They relate to the works of the Messrs. De Wendel. "Their works at Hayange have been in the possession of the family ever since the year 1705. Those at Moyeuvre were started by them in 1825, while the works at Stiring Wendel were commenced in 1846. During the year 1877 these combined works produced 467,000 tons of iron ore; 322,000 tons of coal; 145,000 tons of pig-iron; 87,000 tons of puddled bars; 33,500 tons of merchant bars;

Advantages to Germany of the acquisition of Alsace and Lorraine.

De Wendel iron works.

Production.

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GERMANY.

De Wendel iron works.

8,500 tons of sheet iron; 26,700 tons of rails and sleepers; 2,000 tons of small iron work for railways and mines; 2,500 tons of iron wire; 1,400 tons of French nails; and 8,000 tons of general castings. It was stated that this production is considerably below that of the preceding year." The Messrs. De Wendel have in all 11 blast furnaces. At Moyeuvre were rolled the first rails for the first French railway. Both pig and bar iron are said to be produced by the Messrs. De Wendel at a lower cost than is possible at any other works on the Continent. Although the Messrs. De Wendel do not make steel, owing to the large quantity of phosphorus in their iron ores, they nevertheless have in use all the modern appliances for the manufacture of iron, including the Bicheroux and the Siemens furnaces and Lemud's mechanical puddlers, no iron being puddled by hand.

Economy of production.

Furnaces and mechanical puddlers.

Krupp's works at Essen.

The cast-steel manufactory at Essen has existed since the year 1810. It has been operated by the present owner, Alfred Krupp, since 1826, and since 1848 for his sole account.

Workmen.

Area.

The number of workmen at the close of 1877 amounted to 8,500. The works occupy about 1,000 acres, of which about 187 acres are under roof. There are in these works 1,648 furnaces; 298 steam-boilers; 77 steam-hammers, the largest of all weighing 50 tons; 18 trains of rolls; 294 steam-engines, aggregating 11,000 horse-power, one of the largest having 1,000 horse-power; and 1,063 machine tools. When all existing facilities are employed the works can produce in 24 hours 2,700 rails, which will lay 11⅞ English miles of track; 350 ties; 150 locomotive and car axles; 180 car wheels; 1,000 railroad springs; 1,500 grenades, etc. In one month there can be produced 304 field guns and guns of large caliber. From 1847 to 1877 more than 15,000 guns were produced at these works. The daily supply of coal and coke required is 1,800 tons. In immediate connection with the cast-steel works are 35½ miles of railway, 24 locomotives, 747 cars, 80 horses, and 37⅓ miles of telegraph line, with 44 telegraph stations. At the various mines of Herr Krupp there were employed 5,300 workmen in addition to those already enumerated. These mines embrace 4 coal mines and 562 iron-ore mines, including ore mines near Bilbao, in Spain. At the coal mines are 33 steam-boilers and 48 steam-engines, and at the iron mines are 30 steam-boilers, 23 steam-engines, and 2 locomotives. Four large steamers, owned by Herr Krupp, each of 1,700 tons burden, besides leased steamers, are engaged in the transportation of Spanish ores to his furnaces on the Rhine. Another steamer, of 1,000 tons burden, is being constructed. The

Furnaces, engines, steam machinery.

Machine tools.

Productive power.

Cannon produced 1847–'77.

Supply of coal and coke.

Railways and telegraphs.

Workmen at mines.

Mines, home and foreign.

Ocean steamers for transporting Spanish ores.

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GERMANY.

mines in Spain which are operated by Herr Krupp can deliver 200,000 tons of ore annually. In addition to the cast-steel works and the ore and coal mines, Herr Krupp operates 14 blast furnaces, at which 700 workmen are employed. Ten of these furnaces are of recent construction, each of which can produce an average daily product of 45 tons of pig-iron. At these furnaces are 71 steam-boilers and 48 steam-engines. Herr Krupp also owns and operates at Sayner 2 small blast furnaces for the manufacture of spiegeleisen, and other auxiliary iron enterprises.

Krupp's works. Spanish mines

Blast furnaces

Works at Sayner

The Bochum Company, at Bochum, in Westphalia, manufactures crucible and Bessemer steel on a large scale; also steel castings and forgings, tires, axles, steel cannon, pig-iron, etc. It mines its own coal and iron ore, and makes its own spiegeleisen. The Bessemer plant embraces 7 converters. Cast-steel bells, made of crucible steel, have long formed an interesting specialty of the works of this company. Another specialty is the casting of steel in molds by the method invented by Jacob Meier, its technical director, and which remained for many years the exclusive property of the company. The process of casting steel in forms for use has been perfected and largely practiced in Germany, which country may also be said to have given the greatest impetus to the use of cast steel as a substitute for iron axles and tires upon railways. Werner, at Carlswerk, is claimed to have been the first to make cast-steel axles of good quality, and Krupp invented weldless cast-steel tires.

Bochum Company.

Bessemer plant.

Cast-steel bells.

Meier's process of casting steel in molds.

Werner's cast-steel axles.

Krupp's weldless cast-steel tires.

Germany has been very prominent in the substitution of iron for wood in the building of cars for railroads, in the construction of permanent way for railroads, and in the construction of public buildings and dwellings, telegraph poles, props for mines, etc. The Messrs. De Wendel are running two trains of rolls constantly on iron railway sleepers, and have produced many thousand tons of them.

Iron railway cars.

Iron railway sleepers.

Machinery, tools, cutlery, etc.

Machinery, tools, cutlery, etc.

In the manufacture of machinery, machine tools, cutlery, edge tools, hardware, common and fine castings, and miscellaneous iron and steel products Germany showed at Vienna in 1873 that her people had not neglected the cultivation of the rare mechanical aptitudes which they are known to possess. In some specialties, as the manufacture of wire and scissors, German manufacturers have no superiors. Westphalian wire has a world-wide reputation. In Westphalia are also manufactured for domestic and foreign markets large quantities of anvils, axes, agricultural imple

Wire and scissors.

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GERMANY.

ments, tools, chains, etc. At Berlin are some of the most extensive manufactories of machine tools, locomotives and other engines, agricultural machinery, and beet-sugar machinery in the world. Germany is a large exporter of machine tools. In the manufacture of textile machinery, as of textiles themselves, Germany occupies an advanced position, and to its perfection she has contributed many inventions of her own. In the building of locomotives she has achieved great distinction, and in the supply of neighboring Continental countries she has met with much success. In twelve locomotive works in Germany over 1,000 locomotives have been built annually. At the large locomotive works of Albert Borsig (recently deceased), at Berlin, 1,031 locomotives were manufactured in the six years prior to April, 1873, of which 300 were sent to Russia. This large establishment and an auxiliary establishment in Upper Silesia, under the same ownership, manufacture the pig-iron, rolled iron, steel, boiler plate, axles, etc., required in the construction of locomotives, and besides supply large quantities of these articles to the German market. Siemens-Martin steel is largely made at the works in Upper Silesia. The number of workmen employed at these latter works in 1875 was 3,500, and the number of steam-engines was 45, representing 4,400 horse-power. The works at Berlin are of corresponding magnitude.

Works at Berlin.

Textile machinery.

Locomotives.

Albert Borsig.

Steel works in Upper Silesia.

German iron trade.

The German iron trade.

Schneider's remarks on the German iron industry.

M. Henri Schneider, the head of the great firm of Schneider & Co., at Creusot, in France, is credited with the following declaration before a government legislative commission, in February, 1878, concerning the German iron trade:

> "There are a number of articles in which Germany competes with us with greater effect and is a more dangerous rival than England. The German makers are our chief competitors, and I attribute their formidable development to several causes. In the first place, their industry is based on excellent natural conditions. Germany possesses very considerable mineral wealth, developed under healthy conditions, quite independently of the speculations which of late years have increased the production. In certain provinces, as, for instance, Nassau, and near Siegen, there are special kinds of ore producing a certain quality of iron under most advantageous conditions. Germany has now, too, in Lorraine, the finest deposits in the world for making iron cheaply. I think that ordinary pig-iron can be made cheaper at the present time in Lorraine and Luxemburg than in any place in the world. For iron ores, imported by German makers from Spain for their important make of steel, they enjoy very advantageous sea-carriage rates, and from seaports the forwarding rates into the interior are remarkably low."

Germany's advantages of mineral wealth, favorable conditions of development,

and cheap seaboard and inland rates of transportation.

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GERMANY.

This is high praise from an industrial rival, but it is noticeable that English makers of iron and steel speak slightingly of "dear and bad" German iron made with ore and coal that are found at inconvenient distances, the latter alleged to be of poor quality, and the former largely phosphoriferous. But M. Schneider would hardly express his dread of German competition in French markets if he had nothing to be afraid of; and it is just possible that English manufacturers would have a higher respect for Germany's ability to supply herself with good iron and steel, at fair prices to consumers, if she were not so good a customer for Cleveland and Scotch pig-iron and English bars. To Germany and Holland (the latter almost wholly in transit for Germany) Great Britain annually, during 1875, 1876, and 1877, exported over half a million tons of iron and steel. Against the revenue policy which would continue these large importations German ironmasters and their idle workingmen not unnaturally protest, and they ask that they shall be protected by adequate duties against the advantages possessed by British ironmasters, namely, "the sea for their roadway, cheap shipping, cheap machinery, cheap coal, and the command of cheap capital." They allege that if adequate protection had been afforded them in late years, the excessive importations of iron and steel from Great Britain would not have been possible, and that their own industries and all other German industries would have measurably prospered.

Comparison of British and French opinions of German iron.

English export of iron and steel to Germany.

Arguments in favor of protection to German iron and steel industries.

The anomaly is here presented of France dreading the apprehended competition in her markets of German iron and steel, and of Germany protesting against the competition, already formidable and oppressive, of British iron and steel in German markets. We have here also illustrated one phase of industrial competition from which the United States is practically free, the contiguity or proximity of the territory of an industrial rival. Germany has undoubtedly suffered greatly from British competition, which was rendered possible by reason of the advantages stated and the repeal two years ago of German duties on iron and steel; while Germany herself, by reason of her acquisition of the iron-making districts of Alsace and Lorraine, and for the other reasons assigned by M. Schneider, occupies a threatening industrial attitude toward France. It seems clear that, if trade between these three countries were absolutely free from all restrictions, the German and the French iron and steel industries would both be injured, and those of Great Britain only would be benefited.

French fear of German rivalry.

German protest against British competition.

Probable result were free trade allowed between the three nations.

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GERMANY.

Iron and steel statistics.

Iron and steel statistics.

The following table will show the imports and exports of iron and steel and iron ore into and from Germany in 1876 and 1877:

ARTICLES.	1877.		1876.	
	Imports.	Exports.	Imports.	Exports.
	Metric tons.	*Metric tons.*	*Metric tons.*	*Metric tons.*
Pig-iron	526,708	344,019	571,134	289,417
Scrap-iron	14,225	19,915	12,520	16,783
Steel	5,623	16,145	3,946	17,792
Castings and common hardware	49,276	118,443	35,291	84,109
Rails	76,034	225,630	684	133,484
Bar-iron	36,423	85,431	9,130	51,176
Angle-iron	7,708	4,174	2,136	563
Plates and sheets	18,280	21,208	4,748	11,543
Tin plate	4,082	1,645	3,740	441
Iron and steel wire	3,181	31,791	2,742	15,801
Anchors, cables, etc	3,092	165	1,483	273
Wrought-iron tubes	4,618	5,970	2,410	1,616
Small wares	603	1,527	679	1,328
Iron ore	328,184	804,037	197,537	670,882

All of the leading articles in the table show an increase in importations in 1877 over 1876, except pig-iron, and in this the decline was slight. Bar-iron increased from 9,130 to 36,423 tons; angle-iron from 2,136 to 7,798 tons; and plates and sheets from 4,748 to 18,280 tons. The heavy imports of rails in 1877 were largely in transit for Russia. The large quantity of iron ore exported does not indicate a condition of prosperity for German ironmasters, who would have preferred to export it as manufactured iron.

Imports of coal, etc., into Germany.

The imports of coal, coke, and lignite into Germany in 1877 amounted to 4,750,943 metric tons, and the exports amounted to 5,370,692 tons. The coal and coke imported were principally obtained from Great Britain; the exports of coal, coke, and lignite were almost wholly to neighboring Continental countries.

Great extent of railways in Germany.

Germany has more miles of railroad than any other country except the United States, exceeding even Great Britain, amounting at the beginning of 1878 to 18,828 miles.

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The iron and steel of this small but wonderfully busy country were well represented at the Paris Exposition, again illustrating the achievements of Belgian enterprise, skill, and industry in overcoming great natural obstacles. Belgium has an abundance of coal, but it now contains but little good iron ore. Owing to this scarcity she is largely an importer of iron ore and of pig-iron. These she converts into

Abundance of coal.

Scarcity of ore.

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manufactured iron and steel, for which she finds her chief market abroad. Belgium, more than any other country, sustains an iron industry that is essentially reproductive, and it sustains it too by selling its products to other countries, and to some of the countries from which she derives the raw materials of manufacture. Belgium is, therefore, a workshop rather than a mine; a producer rather than a consumer. So long as she can manufacture iron and steel cheaper than other countries she will find a market for them in countries which have no industries of their own, or do not protect those that they have. These conditions of success are not invested with the element of permanence, for countries that now take Belgian iron may learn to make their own iron or to protect their iron manufacturers who are now distanced by Belgian competition. But, dismissing the future, and having regard only to the present situation, it must be said that the Belgian iron and steel industries are to-day more generally employed than those of many other iron and steel producing countries. Those of Wales are perhaps the least employed. Wales was practically absent from Paris, but Belgium was present in force. Not many years ago Wales regarded the Belgian iron industry with indifference.

Reproductive Belgian industry.

Belgium, a workshop.

Activity of Belgian iron industries.

Inactivity of Welsh iron works.

There is something amazing in the comparative prosperity of Belgian iron and steel industries, with their spare natural resources, at a time when the same industries of more favored countries are experiencing more or less depression. Its causes may be found in cheap labor, long hours, the technical education of workingmen, strict economy in administration, attention to the minutest details, and the use of the most approved labor-saving machinery. The population of Belgium is very dense (5,000,000 in 12,000 square miles), and the country is a hive of industry; there is no room for drones. Every man has his work to do, and he must be content with low wages, for high wages would soon end all employment, by destroying the ability of Belgium to compete in foreign markets. Strikes are, therefore, exceedingly rare, but when they do occur they soon terminate, for the government will not tolerate them. Personal economy is essential to existence. The labor of women and children is utilized. Railroads through its own territory, favorably situated seaports, and a trading spirit handed down from the Middle Ages, aid in securing foreign purchasers for Belgian manufactures. It is thus that Belgium maintains most of her iron and steel works in operation. She utilizes all her resources; she is industrious and frugal, and she neglects none of her opportunities. Much of the distress now existing in other

Causes of Belgian prosperity.

Economy in administration.

Dense population.

Relations of labor.

Personal economy.

Enterprise.

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BELGIUM.

countries might be obviated by the practice of the same virtues, and it would not involve the lowering of wages to the Belgian standard.

Iron and steel exhibits.

Iron and steel exhibits.

John Cockerill Society.

As was the case at Vienna, the principal exhibit of Belgian iron and steel at Paris was made by the John Cockerill Society, of Seraing, five miles from Liège. It comprised specimens of pig-iron, bar-iron, rails, beams, locomotive and boiler plates, tires, axles, forgings, castings, mining machinery, locomotives, car wheels and other railroad appliances, and various other products. A 40-ton eight-wheeled freight locomotive; a 300 horse-power pumping engine; a 500 horse-power rolling-mill engine; two sets of rolls, one of which had rolled 10,500 tons of rails; and two rails, each 180 feet long, one of which had been twisted cold into four spirals, were among the noticeable features of this most interesting exhibit, which was especially rich in heavy machinery. Specimens of the Bessemer steel manufactured by this company embraced razors, knives, swords, bayonets, tools of all kinds, screws, wire, plates, and bars.

Iron, machinery, engines, &c.

Origin of the works.

The works of the John Cockerill Society were established in 1817, by John Cockerill, an Englishman by birth, but a Belgian citizen, and were at first wholly employed in the construction of steam-engines; but in 1823 the erection of a coke blast furnace was commenced, which was blown in in 1826. It was the first on the Continent. Until 1830 it was the only furnace of its kind in Belgium. Forges and a boiler shop were built in 1823 and 1824, a puddling mill in 1826, and a foundery in 1828. From 1830 to 1834 the works were closed, owing to political troubles. In 1835 the first locomotive and the first rails were made. In 1836 a second coke blast furnace was commenced, and in this and the following year other extensions were made. In 1838 John Cockerill became embarrassed, and in 1840 he died. In 1842 the works passed into the hands of the John Cockerill Society, and have since been greatly extended. The first Bessemer steel works in Belgium were erected by this company in 1862. Large purchases of iron-ore mines and coal lands and collieries have been made by it from time to time. It is a large owner of iron-ore mines in Spain. The works now embrace 7 blast furnaces, with two more in course of erection; 2 large foundries; a large iron-rolling mill; a Bessemer steel plant, with 8 converters, each of 7 tons capacity, a rolling mill, etc.; a hammer mill for large forgings; a shop for small forgings; constructing shops for the manu-

Their progress.

Bessemer works.

Spanish ores.

Present plant.

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facture of locomotives, marine and other engines, and other machinery; boiler, bridge, and ship iron works, etc., etc. At Hoboken, near Antwerp, the company owns and operates an extensive ship-yard, at which 410 steamships, transports, monitors, and armored vessels have been built. It owns several vessels that are engaged in the transportation of iron ore. Its nominal capital stock is $3,000,000. It now employs 8,850 workmen at all its enterprises, to whom if pays $2,000,000 annually as wages. Its annual sales amount to about $8,000,000. It has in use 252 engines, and its daily consumption of fuel is about 1,100 tons. The annual capacity of the company is equal to the production of 400,000 tons of coal; 150,000 tons of native ore; 170,000 tons of foreign ore; 100,000 tons of pig-iron; 6,000 tons of castings; 25,000 tons of girders, iron plates, and bar-iron; 1,000 tons of steel plates; 100,000 tons of steel rails, bars, and tires; 1,500 tons of steel ordnance, car wheels, locomotive wheels, etc.; 8,000 tons of steam-engines and mechanical apparatus; 10,000 tons of bridges, boilers, and structural iron; and 14 ocean or river vessels. The company has frequently rolled 365 tons of rails in 24 hours. The number of locomotives annually built is about 100; of steam-engines, 70; and of machines of all kinds, 100. In the fiscal year 1877–'78 the greatest activity prevailed in the Bessemer steel works, which produced 83,000 metric tons of steel, a large increase upon 65,000 tons in 1876–'77. The company also made 57,000 tons of rails in 1877–'78, an increase upon 45,000 tons in 1876–'77. The works at Seraing cover 220 acres, and at Hoboken 22 acres. Such is a representative Belgian iron and steel enterprise.

John Cockerill Society.

Capital.

Sales.

Fuel.

Production.

Rails, locomotives, and engines.

Area.

Other iron and steel exhibits in the Belgian section, by the Angleur, Espérance, Ougrée, Sclessin, Providence, Couillet, Chatelineau, and other companies, were scarcely less interesting than that of the Cockerill Company. They embraced iron and steel rails, plate and sheet iron, bar-iron, beams, and girders, pig-iron, iron ores, and Bessemer and Siemens-Martin steel in various forms. The display of beams, girders, and joists was very large, some of the specimens being of exceptional lengths and novel sections. The company at Angleur exhibited fine Bessemer steel castings. The sheet-iron exhibited by the Espérance Company was in all respects excellent. The ironmasters of the Charleroi district contributed a consolidated exhibit of beams, girders, rails, wire, sheets, pig-iron, etc., which was very attractive. There was a good display of cast-iron pipes. Locomotives

Exhibits of the Belgian companies.

Iron and iron constructions.

Sheet-iron.

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and railway cars from the shops of the Compagnie Belge of Brussels, and several other companies were among the prominent exhibits; and it may be mentioned that the building of steam-engines, locomotives, and other railway rolling stock for export is a leading branch of Belgian industry, the cities of Brussels, Seraing, Liège, Couillet, Tubize, and others being engaged in their manufacture. The display of tires, axles, locomotive springs, and other railway appliances was good. Mining machinery was another leading feature of the Belgian exhibit. A noticeable display of machine tools, engines, steam-pumps, hydraulic presses, beet-sugar machinery, etc., was made by Cail, Halot, & Co., of Brussels. Machine tools were quite numerous in the Belgian section, and these and the heavy machinery were usually excellent. The display of iron wire, especially of gauges below No. 20, was large and creditable, and several machines were exhibited which make wire nails and tacks. But the Belgian display of general hardware, fine cutlery, small castings, edge and other tools, and agricultural machinery was neither large nor impressive. The Belgian iron and steel industries appear to have been developed most in the direction of rolling-mill products and heavy machinery. The bar-iron of Belgium has long been celebrated for its excellence. There were creditable displays of coke and compressed fuel. The latter was a prominent feature of the Belgian exhibit, and its manufacture in Belgium is so extensive as to have justified this prominence. Coal mining in Belgium dates from the twelfth century.

Steam engines, locomotives, and railway rolling stock for export a leading Belgian industry.

Cail, Halot & Co.

Pumps and machine-tools.

Iron wire

Compressed fuel.

Iron and steel history and statistics.

Iron and steel history and statistics.

The Belgian iron industry is of very great antiquity, dating from about the beginning of the Christian era. It appears to have never ceased to exist from that time until the present. At first the most primitive processes were employed, and afterwards blast furnaces and refinery forges. There was a charcoal furnace in operation at Dames, near Namur, in 1340. At the close of the fifteenth century leather bellows were in use for driving blast furnaces in the district of Liège. In 1560 Belgium had 35 blast furnaces and 85 forges. In 1693 a "splitting mill" is mentioned. Down to 1800 the furnaces were octagonal in form and only about 15 feet high; in that year circular furnaces were introduced; they were built 25 feet high, and the remarkable product of three tons a day was realized. Charcoal becoming very scarce, John Cockerill was successful in 1826 in introducing the use of coke in the blast furnace. In 1830 the coke fur-

Early history.

Furnaces.

Splitting mill.

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nace in Belgium that would yield 2,000 tons of pig-iron in a year was doing well. The puddling of iron and the use of grooved rolls were introduced into Belgium from Great Britain soon after the battle of Waterloo restored peace to Belgium and to Europe, the first puddling furnace in the kingdom having been erected in 1821. Belgian iron-masters have not been slow to observe and to utilize the improvements of other countries. In 1872 the Danks puddling furnace was introduced by the Société Anonyme of Sclessin, and about the same time Lauth's three-high plate rolls were adopted by the Ougrée and Espérance companies.

History of Belgian iron industry.

Danks puddler.

Lauth's three-high rolls.

Steel was first made in Belgium in 1753, but its manufacture was never largely developed until 1862, when the first Bessemer steel works in the kingdom were established. Just prior to that event, in the year 1860, Belgium produced only 3,172 tons of steel, part of which was crucible steel and part what is termed German steel. A year ago there were but three Belgian works engaged in the manufacture of steel by casting: The Cockerill Company, with 8 Bessemer converters; Rossius, Pastor, & Co., at Angleur, with 4 Bessemer converters; and the Sclessin Company, at Tilleur, with a Siemens-Martin plant. Since then the Ponsard furnace has been introduced by the Société de Thy-le-Château for the production of steel rails. The Ougrée Company is also erecting a gas furnace, with the view of making steel by the open-hearth process.

History of Belgian steel industry.

Cockerill Company.

Rossius, Pastor & Co.

Sclessin Company.

Ponsard furnace.

Society of Thy-le-Château.

Ougreé Company.

The statistics of the Belgian iron, steel, and coal industries are very full and complete. There are about 70 blast furnaces in the kingdom, 56 being the largest number that were ever in blast in one year. Only 26 were in blast in 1877, a fact due mainly to the increasing scarcity of native ore, but partly to foreign competition, and partly to the unsuitableness of domestic ores for Bessemer steel. The pig-iron branch of the Belgian iron trade is therefore only moderately prosperous. The production of pig-iron in recent years has been as follows: 1850, 144,452 metric tons; 1860, 319,943 tons; 1870, 565,234 tons; 1872, when the maximum was reached, 655,565 tons; 1876, 571,267 tons, the decline being gradual from 1872. The production of wrought iron, bar-iron, blooms, plates, iron rails, etc., was 61,970 metric tons in 1850; 200,596 tons in 1860; 491,563 tons in 1870; 510,920 tons in 1874, when the maximum was reached; and 416,714 tons in 1876. In 1877 and 1878 there was an improved foreign demand for the products of Belgian rolling mills, and production was slightly increased. In 1875 Belgium produced 20,440 metric tons of chains, cables, an-

Statistics of Belgian iron, steel, and coal industry.

Pig-iron.

Wrought iron.

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chors, nails, etc., and in 1876 the production of castings was 80,759 tons. The production of steel was 3,172 metric tons in 1860; 9,563 tons in 1870; and 75,258 tons in 1876. Of the production in 1876, 71,758 tons were Bessemer steel, of which 65,000 tons were rolled into rails. The production of Bessemer steel exceeded 100,000 tons in 1877. In the fiscal year 1877–'78 the John Cockerill works alone produced 83,000 tons of Bessemer steel. The production of steel in Belgium is steadily increasing. The production of iron ore has rapidly declined from 1,018,231 metric tons in 1865 to 269,206 tons in 1876.

Production of steel.

Coal.

The production of coal in Belgium steadily increased from 3,929,962 metric tons in 1840 to 15,778,401 tons in 1873, when the maximum was attained. There was a decline in 1874, a slight recovery in 1875, and a decline to 14,329,578 tons in 1876. To this may be added the production in the same year of about 300,000 tons of artificial mineral fuel, or *briquets*, which has since been increased to about 500,000 tons annually.

Artificial mineral fuel.

Imports and exports.

The Belgian imports and exports of iron ore, pig-iron, manufactured iron, and steel for 1878 were as follows: Iron ore, imports, chiefly from the Grand Duchy of Luxemburg, 833,922 metric tons; exports, chiefly re-exports to France, 239,728 tons. Pig-iron, imports, chiefly from England, Germany, and the Grand Duchy, 210,353 tons; exports, 5,362 tons. Manufactured iron, imports, 8,575 tons; exports, 191,062 tons. Nails and wrought-iron sundries, imports, 3,409 tons; exports, 26,444 tons. Castings, imports, 2,030 tons; exports, 10,509 tons. Steel, imports, 4,992 tons; exports, 36,816 tons. These figures show a total of 229,299 tons of imports and 270,193 tons of exports. Belgium's exports of machinery are large. Of the exports of iron and steel in 1878 no less than 58,282 metric tons were sent to Great Britain, of which over 49,000 tons were merchant iron and the remainder was nails, rails, etc. The Belgian exports of rails have greatly declined since 1874, but the other iron and steel exports have been well maintained.

Iron and steel.

Coal.

The imports of coal and coke into Belgium in 1876 amounted to 832,296 tons, Great Britain being the principal contributor, and Germany supplying a large part of the remainder. The exports in the same year were 4,399,605 tons, almost wholly to France.

AUSTRIA-HUNGARY.

AUSTRIA-HUNGARY.

Americans do not usually associate the Austrian Empire with the manufacture of iron and steel on a large scale, and

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yet these are among its most important productions, and the industries devoted to them have an honorable rank in comparison with like industries of other countries. Austria (in which I include Hungary) is the sixth among iron and steel producing countries, and she occupies no mean place as a manufacturer of machinery. As a manufacturer of textiles, glass ware, and other light products of skilled industry, as a manufacturer of beet-sugar, and as the liberal promoter of an extensive railway system, she occupies a position of well-deserved prominence. With internal and external peace, and perseverance in the tolerant and conciliatory policy which now characterizes the administration of her affairs, Austria may be expected to become within the next ten years one of the very first among industrial nations. That she has not been generally recognized in our country as a possible future rival in the production of iron and steel is mainly due to our lack of commercial intercourse with her people, but partly, also, to the almost total absence of Austrian iron and steel products at the Philadelphia Exhibition in 1876. When it was held, the interest in international exhibitions of her iron and steel producers and of many other Austrian manufacturers appeared to have been exhausted by their splendid contributions to the Vienna Exposition in 1873. But Austria grandly rallied in 1878 from her lethargy in 1876, and her whole display at Paris was exceedingly interesting, her iron and steel exhibits being especially large and varied.

The sixth among iron and steel producing countries.

Misconception of the productive power of Austria-Hungary.

Large and interesting display.

Iron and steel exhibits.

Iron and steel exhibits.

The principal Austrian exhibitors of iron and steel and of railway material at Paris were the Austrian and Hungarian State Railway Companies, closely followed, however, by other large companies. It is a peculiarity of the iron and steel and coal industries of the empire that the government railroad companies are extensively engaged in their development and at widely separated localities; and it is also a peculiarity of these industries that the companies which were organized expressly and solely to engage in their development have their enterprises as greatly scattered as those of the railroad companies. These results have largely grown out of a spirit of speculation which was rife in Austria a few years ago, many of the speculations proving to be disastrous. The financial stringency which occurred in Austria early in 1873 was the beginning of the period of world-wide depression, the end of which we have not yet seen. Large stock companies were organized to absorb and

Austrian and Hungarian State Railway Companies the principal exhibitors.

Scattered enterprises.

Speculative period, followed by stringency of 1873.

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Organization of consolidated small enterprises.

operate various consolidated small enterprises. Most of these inflated organizations still remain in existence, but their stock has greatly contracted in value. They have served a useful purpose in stimulating the development of Austrian mineral resources, and in relieving the empire of dependence upon other countries for iron and steel and things made from them.

Austrian exhibit of iron and steel.

The exhibit of iron and steel and their products which was made by Austria embraced the same classes of heavy articles that were exhibited by France, Great Britain, and Belgium:

Iron and iron production.

Pig-iron of various grades; iron and steel rails; Bessemer and Siemens-Martin steel; spiegeleisen; crucible, puddled, and cemented steel; rolled iron for building purposes; plates and sheets; axles and tires; locomotives and other railway requisites; chilled car-wheels; tubes and pipes; iron permanent way for railroads; a general assortment of heavy and light machinery, etc., etc. Joined to these were samples of fuels and iron ores. Much of the pig-iron was made with charcoal, and was excellent in quality, being specially adapted to the manufacture of steel. The locomotives were among the finest in the Exposition. About 1840, when Austria began to build railroads, she adopted the American locomotive as a model, and the Austrian locomotives of to-day are very similar to those of the United States. Railroad crossings of chilled iron were exhibited by Ganz & Co., of Buda-Pesth, who also exhibited a fine collection of chilled car-wheels of American style, one of which had run 329,400 miles and another 380,000 miles. It is stated that chilled car-wheels have been used on the Emperor Ferdinand Railway, in Northern Austria, since 1855, and have ever since increased in number, so that now, with 10,000 freight cars, 23,140 such wheels (21,696 from Ganz & Co. and 1,444 from Count Andrassy's works at Dernoe) are in use. Projectiles made of chilled cast iron were also exhibited by Ganz & Co. Two styles of iron permanent way were exhibited, several systems of which have been introduced upon Austrian and Hungarian railroads. Of sugar-making machinery there was a large display, but of agricultural machinery and implements the display was greatly inferior to that of France, Great Britain, or the United States. The exhibit of wood-working machinery was small. Stationary and portable engines were numerous in the Austrian and Hungarian sections. Boilers made of Bessemer-steel plates were exhibited by the Emperor Ferdinand Railway Company, and good boiler plates of Bessemer steel were exhibited by the Hungarian State Railway Company. Steel armor-plates were

Fuels and ores.

Locomotives.

Adoption of American model.

Ganz & Co.

Chilled car-wheels.

Count Andrassy's works.

Permanent way.

Sugar machinery.

Steam engines.

Boilers of Bessemer-steel plates.

Armor-plates.

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exhibited by J. Braun's Söhne, of Schöndorf. The exhibit of wire, wire rope, and wire work of all kinds was very extensive. Austria vies with Westphalia in the manufacture of products of this class. Car and carriage springs were shown in profusion, as were railway appliances generally. A locomotive fire-box, made of Siemens-Martin steel, with arched and corrugated sides and top, was a prominent object.

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Wire and wire-rope.

Springs.

Tools.

Tools.

Franz Wertheim & Co. and John Weiss & Sons exhibited fine collections of bench tools. The former firm also exhibited fire and burglar proof safes. Miners' tools were exhibited by Mahler & Eschenbacher. J. Braun's Söhne exhibited files. The Eisen and Stahlgewerkschaft, of Eibiswald, exhibited a number of circular and band-saws. The display of cutlery was meager, and very inferior to that made by Austria at Vienna. Like Belgium, the Austrian display of iron and steel and their products at Paris was notably rich in heavy articles and heavy machinery. It was not seriously deficient in small wares, the manufacture of which requires delicate manipulation or the application of delicate machinery, but they did not form one of its prominent features.

Bench tools.

Safes.

Miners' tools.

Files.

Saws.

Machinery.

Distribution of the iron industry.

Distribution of the iron industry in Austria-Hungary.

The manufacture of iron and steel in the Austrian Empire is distributed over a large part of its territory, which may be divided into three grand divisions. The most prominent of these is in the southwestern part of the empire, and embraces Styria, Carinthia, and the remaining provinces of the Austrian Alps. This district is remarkably rich in iron ores of superior quality, principally spathic, this variety being practically free from impurities, and well adapted to the production of steel, in which it is now largely employed. The spathic ores of Austria and Hungary have long been celebrated as among the best steel-producing ores in the world. In Styria and Carinthia are situated the two famous iron mountains, Erzberg and Hüttenberg, which were worked by the Romans and by the Celts two thousand years ago. In late years the Erzberg has yielded 175,000 tons of iron ore annually. Iron has been made in these Alpine provinces in furnaces of various forms of construction since the eighth century. Until the present century charcoal was the only fuel that was used, both in the furnaces and in refinery forges, but now wood, brown coal or lignite, and coke are also used. Lignite of excellent quality is found in Styria,

Spathic ores.

The iron mountains of Erzberg and Hüttenberg.

Fuel used formerly, and now.

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and it is used with satisfactory results in blast furnaces and puddling furnaces. Extensive deposits of lignite, which have not yet been developed, are found on the line of the railroad from Vienna to Trieste. Peat is also largely used in Styrian puddling furnaces, partly in the ordinary way and partly in connection with Siemens regenerative furnaces. True bituminous and anthracite coals are found in the Alpine provinces, but not in appreciable quantities.

Lignite.

Peat.

Coal.

N. W. division of the empire. Bohemia, etc.

The next most important division is in the northwestern part of the empire, and embraces Bohemia, Moravia, and Austrian Silesia. Iron was made in Bohemia long before the beginning of the Christian era. In some portions of this district there is good coal in large quantities, which makes an excellent coke for blast-furnaces, but in others coal is scarce or impure, and lignite and wood are used. Lignite is abundant, and of good quality. Bohemia produces more than one-half of all the coal and lignite mined in the empire. The iron ores of this division are not generally so pure as those of the Alpine provinces, but included in them are some rich deposits of magnetic, specular, spathic, and red and brown hematites. Many of the ores are manganiferous. Much of the iron of this district is well adapted to foundry purposes, and it has been customary to make large and small castings direct from the blast furnace. Cupola foundries, some with hot-blast, are, however, common, and usually well employed. Until quite recently charcoal has been the only fuel used in this district, and it is still largely consumed in blast-furnaces and in a few blomaries or refinery forges. Blomaries were only a few years ago very numerous in this district, Bohemia alone having 110 in 1865, which converted into wrought-iron a large part of the product of 28 blast-furnaces; now, however, puddling furnaces are numerous, in 1871 there being 116 in Bohemia and 70 in Moravia and Silesia.

Ancient iron-working.

Coal and lignite.

Iron ores.

Foundries.

Blomaries.

Puddling furnaces.

Carpathian mountains region.

The third division into which the Austrian iron industry is territorially divided embraces the extensive provinces lying wholly or in part in the Carpathian mountains—Hungary, Galicia, Buckowina, Transylvania, and others. This division, like the one last named, has a variety of ores, a large proportion of them being of good quality. The development of large deposits which are known to exist in Galicia and elsewhere has scarcely been commenced, while others have been worked for centuries. The primitive wolf furnaces are still to be found in use in this district, as well as bloomaries; but charcoal and coke furnaces, rolling-mills, and yet more modern processes are numerous. Charcoal is

Primitive furnaces and modern processes.

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the principal fuel used in the blast furnaces. Coal is scarce, but lignite is abundant.

First puddling and coke blast-furnaces in Austria.

The first puddling furnace in Austria was built at Witkowitz, in Moravia, in 1826, and at the same place the first coke blast-furnace in the empire was built in 1838. From these two events may be dated the beginning of the modern iron industry of Austria. The first coke furnace in the Alpine provinces was erected at Prewald, in Carinthia, in 1870; the first puddling furnace in Carinthia was erected in 1828.

Styrian and Carinthian steel.

German steel made in Styria and Carinthia was celebrated for its excellence fifty years ago, when the annual production was about 15,000 tons, a part of which found its way to American markets. These provinces have also, for many years, made crucible steel of excellent quality.

Crucible steel.

Puddled steel.

Puddled steel has been made in Austria since 1835, but in large quantities only since 1852. It was at one time largely used for rails. It is still made in small quantities.

Bessemer steel.

The first Bessemer steel works in Austria were commenced at Turrach, in Upper Styria, in 1862; there are now 13 works in the empire, with 32 converters. These works are located in various provinces, but principally in Styria. At most of the works the pig-iron is run direct from the blast furnace into the converter. At the works at Reschicza, in Hungary, there are three converters, each of 9 tons capacity; the annual production of the works is, however, only about 9,000 tons.

Spiegeleisen.

Spiegeleisen is manufactured at several places in Austria;

Ferro-manganese.

ferro-manganese is also manufactured in blast-furnaces in the province of Carniola, and probably elsewhere.

Siemens furnace.

Siemens furnaces have been used in Austria since 1858, when they were introduced at Kapfenberg in connection with the manufacture of cast steel.

Siemens-Martin process.

In 1867 the Siemens-Martin process was introduced at the same place, but the manufacture of steel by this process has never been greatly extended in Austria, the earlier processes and the Bessemer process being in greater favor.

Tin-plate.

The manufacture of tin-plate has been thoroughly established at several places.

As has already been intimated, there are many strong companies engaged in the manufacture of iron and steel in Austria and Hungary, and their enterprises have been projected on a scale worthy of more prominent iron and steel making countries.

Iron and steel statistics.

Iron and steel statistics.

The whole number of blast-furnaces in the Austrian Empire in 1876 was 279, of which 166 were in blast and 113

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Iron and steel statistics.

were out of blast. The production of pig-iron and castings from the blast furnace in 1840 was 144,352 metric tons; in 1850 it was 223,045 tons; in 1860 it was 348,798 tons; in 1870 it was 452,244 tons; in 1873, when the maximum was attained, it was 594,980 tons; in 1876 it was 450,933 tons. These figures show a more gradual increase in the production of pig-iron than has been the experience of some other countries, and they also show a smaller proportionate decrease in production since the culminating point was reached in 1873. The present blast-furnace practice of Austria and Hungary is perhaps presented in its most favorable aspect in the record made in 1873 by two Buttgenbach coke-furnaces erected by the Innerberger Company at Schwechat, near Vienna. They are each 60 feet high, 18 feet diameter at the boshes, 12 feet diameter at the top, and 7 feet across the hearth. There are two blowing engines, each of 360 horse-power. In 1873 each furnace made 50 tons of pig-iron daily from 112½ tons of Styrian spathic ore, 7½ to 12½ tons of limestone, and 62½ tons of coke.

Blast-furnaces of the Innerberger Company.

Rail-mills.

At the close of 1877 there were 17 rail-mills in the empire The course of the rail manufacture since 1870 is seen in the following table:

Statistics of rail manufacture.

Year.	Iron rails.	Steel rails.	Total.
	Metric tons.	*Metric tons.*	*Metric tons.*
1870	89,700	17,307	107,097
1871	90,463	23,199	113,662
1872	86,556	38,009	124,565
1873	80,742	50,327	131,069
1874	54,797	57,169	111,966
1875	40,155	61,345	101,500
1876	22,819	64,491	87,310
1877	18,645	79,065	97,710

Steel rails.

These figures indicate the same tendency to substitute steel rails for iron rails that is observable in other countries. The growth of the Bessemer steel industry in Austria has, however, been very slow. In 1864, when the first works went into operation, the production was 306 metric tons; six years later, in 1870, it amounted to only 20,722 tons, with 6 works in operation; in 1874 it reached 96,958 tons, with 9 works in operation Since that year the production has twice fallen slightly below 90,000 tons; but in 1877 there was an increase to 97,470 tons, with 13 works and 32 converters in existence, and 11 works and 28 converters in operation. The exceedingly small output of so many works and converters is in part accounted for by the small size of the converters, which are generally of from 2½ to 3 tons capacity.

Bessemer practice.

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The production of iron ore in the Austrian Empire amounted to 573,079 metric tons in 1851, and in 1873 it amounted to 1,588,256 tons, the increase in the mean time being gradual. From 1873 to 1876 there was a steady decline in production, the figures for the latter year being 902,421 tons.

Iron ore output.

Coal.

The production of coal in Austria and Hungary, the mining of which dates from the middle of the sixteenth century, amounted to only 94,607 metric tons in 1819, and to only 944,323 tons in 1850. In 1855 there was an increase to 2,101,050 tons; in 1865 to 5,069,303 tons; in 1870 to 8,355,944 tons; and in 1876, when the maximum was reached, to 13,362,586 tons, of which 5,564,331 tons were pit coal and 7,798,255 tons were lignite.

Imports of iron and steel.

The imports of iron and steel into the Austrian Empire have undergone as great a change in late years as have similar imports into our own country since 1873. From 1866 to 1872 the imports of pig and scrap iron increased from 131,351 metric tons to 219,078 tons, but in 1876 the imports were only 38,057 tons From 1868 to 1870 the imports of rails rose from 54,218 tons to 116,813 tons, but have since steadily fallen to 805 tons in 1876. The imports of bar-iron have fallen from 27,880 tons in 1872 to 1,458 tons in 1876. The imports of hardware and machinery have fallen from 64,551 tons in 1872 to 20,363 tons in 1876. The imports of steel have fallen from 1,127 tons in 1871 to 880 tons in 1876.

Exports.

The exports of iron and steel from Austria have increased in recent years until in many particulars they now exceed the imports. In 1875 the exports of rails amounted to 10,774 metric tons, but fell in 1876 to 4,325 tons. In 1875 the exports of pig and scrap iron reached to 10,727 tons, but fell in 1876 to 7,317 tons. The exports of bar-iron amounted to 7,056 tons in 1875, and to 8,304 tons in 1876. The exports of hardware and machinery reached to 26,886 tons in 1874, but fell to 19,926 tons in 1876. The exports of steel of all descriptions have not greatly varied from 4,000 tons annually from 1866 to 1876.

Imports of ore.

The imports of iron ore have always been inconsiderable, the largest quantity having been reached in 1872, when 15,675 metric tons were imported, since which year there has been a steady decline to 2,429 tons in 1876. The exports of iron ore appear to have been highest in 1875, when the quantity amounted to 52,817 tons; in 1876 there were 38,159 tons sent out of the country.

Imports and exports of coal.

Since 1865 the imports and exports of coal into and out of Austria have both grown steadily, owing mainly to the

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completion of railway communications with neighboring countries, but the exports have increased the most. In that year the imports were 366,488 metric tons, and the exports were 385,662 tons. In 1876 the imports were 1,574,575 tons, and the exports were 2,734,862 tons.

Coal imports and exports.

The foregoing statistics and other references appear to establish conclusively the fact that Austria is possessed of sufficient resources to enable her to supply her own iron and steel wants, and the further fact that she is now supplying them. Recent information leads to the conclusion that the government of the empire will pursue a revenue policy that will tend at least to confirm Austrian iron and steel manufacturers in the possession of the home market.

Ability of Austria to supply her own wants.

RUSSIA.

RUSSIA.

Russia ranks seventh among iron-producing countries, and her exhibit of iron and steel products at Paris was worthy of her rank. Although the iron industry of Russia is not of recent origin, having existed long before the days of Peter the Great, two centuries ago, it has not been characterized by a progressive spirit nor by notable activity until within the past few years. The present Emperor, Alexander II, has given to it greater encouragement and a greater impetus than any one of his predecessors. This he has done by a variety of measures, including a protective tariff, bounties to special manufactures, and the extension of railroad communications. It will be a long time, however, before all the widely-separated parts of his vast empire will be joined together with iron bands, as the United States is now joined, and in the mean time it is too much to expect that Russia, wise as her ruler is, and enterprising as her ruling classes are, will be able to fully utilize her scattered mineral resources. She is not wanting in iron ore nor in fuel to smelt it and to refine the iron obtained from it; but she is largely wanting, because of the vastness of her territory, in the means necessary to bring the fuel to the ore and the iron to a market. It is, therefore, all the more to her credit that she has made even limited progress in the development of her iron resources, and that her iron and steel makers were enabled to make the fine display they did at Paris. The Russian iron and steel exhibit was one of the most valuable and most interesting in the Exposition. It was mainly composed of articles which charcoal and not mineral fuel had produced, a fact suggestive of immense possibilities, for if such progress could be made with a fuel which has never

The seventh in rank of iron-producing countries.

Encouragement by Alexander II.

Abundance of ore and fuel.

Lack of transportation.

Charcoal iron.

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yet fully developed the iron resources of a single country, not even excepting Sweden, what may not be possible when her extensive deposits of mineral fuel come generally into use as an addition to the vast quantities of charcoal which the boundless Russian forests are yet capable of supplying when they shall be penetrated by Russian railroads?

Prospective development.

Iron and steel exhibits.

Iron and steel exhibits.

The principal exhibitor in the iron and steel department of the Russian section was Prince Demidoff, whose extensive works in the Ural Mountains, where he owns a million and a half acres of forests and mineral lands, have long been noted. He is a large manufacturer of pig-iron, finished iron, and Bessemer and other steel. The Russian Government works and several private companies were also well represented. The entire exhibit embraced samples of magnetic and other iron ores of extraordinary richness and purity; fine samples of charcoal pig-iron; and a full assortment of bar-iron, sheet-iron, plates, rods, iron wire, axles, tires, car-wheels, iron and steel rails, Bessemer and Siemens-Martin steel, crucible and puddled steel, projectiles, swords, chains, etc. Prince Demidoff showed Bessemer-steel boiler plates of excellent quality; also Bessemer-steel rails 45 feet long, and another steel rail 50 feet long, which had been twisted cold; also plates and rods of Siemens-Martin steel, some of which had been bent and broken to show their quality; also a disk of the same kind of steel, $\frac{3}{4}$ of an inch thick, and 7 feet 5 inches in diameter. The same exhibitor also showed a variety of steel tools, scythes, swords, etc.

Prince Demidoff.

Admirable exhibit of ores, iron, and manufactures of iron and steel.

Rails and plates of Bessemer and Siemens-Martin steels.

Several kinds of steel, all of excellent quality, were shown by several exhibitors, with fine effect. The Imperial Technical School of Moscow made a good display of tools, as did also a few other exhibitors.

Imperial Technical School of Moscow.

The display of cutlery was not large, but it was remarkably good, and indicated not only the possession by Russia of the best of steel, but the possession also of the best of skill in its manipulation. The knives, forks, scissors, and swords exhibited were not surpassed in excellence by any similar display.

Cutlery.

Hackman & Co., a Finnish firm of Wiborg, were prominent among the Russian cutlery exhibitors. In their works they employ 90 men.

Hackman & Co.

In machine and other castings the Russian section was not far behind the best of its competitors, but in heavy machinery, agricultural implements, and railroad appliances it was deficient in extent and variety. The Industrial Society

Castings.

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RUSSIA.

of Varsovie exhibited a collection of car couplings, car springs, and wrought-iron car wheels. A few steam-engines of creditable workmanship were exhibited, as were detached parts of engines, well made and exquisitely polished. Much of the engine work was produced by the pupils at the Industrial Schools of Moscow and St. Petersburg.

Exhibit of Industrial Societies and Schools.

Lilpop, Rau, & Loewenstein.

Messrs. Lilpop, Rau, & Loewenstein, of Varsovie, exhibited beet-sugar machinery.

Beet-sugar machinery.

Coal.

Specimens of the bituminous and anthracite coal of Russia were exhibited, the former of various qualities, and the latter said to analyze 90 per cent. of carbon.

Iron and steel industries.

Iron and steel industries.

The iron and steel industries of Russia may be said to have the whole empire for their home, for they are found in many parts of it—in the Ural Mountains in the east, in the Donetz Mountains in the south, in the vicinity of Moscow in the center, in Poland and neighboring territory in the west, and in Olonetz and Finland and at St. Petersburg in the north. The Ural Mountains produce more than half of the pig-iron annually made in Russia, and a large part of the finished products. At and near St. Petersburg is displayed the greatest localized activity in the production of rails, plates, steel, and some other finished products. Bessemer steel is now made successfully at three or four establishments in the empire, and open-hearth steel is made at many places in Siemens-Martin and Pernot furnaces. Crucible and puddled steel of good quality have long been made. Chrome steel, from native ores, is made at the Obouchoff Steel Works, near St. Petersburg. Siemens regenerative furnaces are common. Spiegeleisen is successfully made in Finland and in the Ural Mountains. Russian ores are of various qualities, magnetic, specular, brown and red hematites, etc. Some ores are taken from the bottom of bogs and lakes, and they are found in quantities which are practically inexhaustible. No other country in Europe is better supplied with good ores than Russia, not even Sweden and Spain. The magnetic mountain of Blagodat, in the Ural Mountains, is one of the richest and most remarkable iron-ore deposits in the world. It has been worked for 140 years.

Regions of activity.

Bessemer and open-hearth steel.

Crucible, puddled, and chrome steel.

Spiegeleisen.

Ores of fine quality.

Magnetic ore.

Iron works of Kolpina.

At Kolpino, near St. Petersburg, on the railroad leading to Moscow, extensive works have recently been erected for the manufacture of boiler and ship plates, armor plates, beams, angles, bars, and other iron for use in the government ship-yards and in the construction of government buildings.

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Obouchoff Steel Works.

At Alexandrovsky, near St. Petersburg, are situated the Obouchoff Steel Works, at which heavy steel guns are manufactured from crucible cast steel. Ingots of steel weighing 40 tons and upwards have been cast at these works, each 40-ton ingot requiring the use of 1,200 crucibles. An 80-ton gun was made here a few years ago, the ingot for the breech-block of which weighed nearly 50 tons, and was hammered into shape under a 50-ton hammer. Most of the crucibles are heated with imported coke, but Siemens gas furnaces supply heat to others. A Bessemer converter, of 5 tons capacity, has been in use for several years. These works make weldless tires, wheels, axles, shafts, boiler plates, etc., for Russian railroads, all of Bessemer or open-hearth steel. They were established about twenty years ago, and now employ 2,500 men.

Plant and productions.

2,500 workmen.

Poutiloff rail-mill.

Near St. Petersburg is the largest rail-making establishment in Russia, the Poutiloff Works, which produces annually about 16,000 tons of rails and 4,000 tons of steel tires and other finished products. At these works Bessemer converters have been in use for several years and a large Siemens steel plant has been erected. There are connected with these works four charcoal-furnaces and a rolling-mill in Finland.

Plant.

Russian Engineering and Mining Company. Iron works and ship-yard.

On the Neva, five miles from St. Petersburg, is a large plate and merchant bar-mill and a ship-building yard, owned by the Russian Engineering and Mining Company, with a capital of about $5,000,000. This company built the "Grand Admiral" a few years ago, the engines for which were supplied by a St. Petersburg firm. The armor plates for the Russian imperial frigate, the "Duke of Edinburgh," were, however, made at the Motala Works, in Sweden.

Rail-mill of Briansk.

At Briansk, on the Orel-Witebsk Railway, a large mill for re-rolling iron rails, and for the manufacture of iron bridge work, was started in June, 1874.

Imperial Gun Foundry at Perm.

The Imperial Gun Foundry at Perm, in the Ural Mountains, is an extensive establishment, which has long been engaged in the manufacture of cannon and projectiles, musket barrels, and other warlike material. It has recently been greatly enlarged. Steel has long been manufactured here in crucibles, and a Pernot furnace is now in use.

Jjeff Arms Factory at Kama.

At Kama the Jjeff's Arms Factory is employed in the manufacture of needle-guns, and crucible-steel is here made with Siemens gas-furnaces, charcoal being used as fuel.

Nijni-Salda Iron Works of Prince Demidoff.

At the Nijni-Salda Iron Works of Prince Demidoff a very complete Bessemer plant was added in 1875. The converters are of 5 tons capacity, and the metal is run into

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RUSSIA.

them direct from blast-furnaces specially constructed for this purpose. A new rolling-mill, with a 350 horse-power steam-engine, has been added to the one previously in use. The machinery for these improvements was largely manufactured at Nijni-Taguil, where some of Prince Demidoff's works are located, and where a Siemens-Martin plant has recently been erected, with a capacity of 32 tons of steel daily. Spiegeleisen is made at Taguil.

Nijni-Taguil.

New Russia Co.

The New Russia Company, founded by Mr. John Hughes, owns blast-furnaces and rail-mills in Donetz Valley, Southern Russia. A Siemens-Martin steel plant has recently been erected at these works, and the Russian Government has lately given the company orders for steel rails aggregating 43,225 tons.

Vyksounsky Co.

In Southeastern Russia are located the various iron enterprises of the Vyksounsky Company, an English organization, which possesses four hundred thousand acres of forests and mineral lands, and carries on the iron manufacture in many of its branches, making pig-iron, bar-iron, tires, hoops, plates, sheets, telegraph and other wire, nails, steam-engines, and other heavy machinery. The works of this company are greatly scattered.

Polish works at Huta Bankowa.

At Huta Bankowa, in Russian Poland, are four blast-furnaces and a rolling-mill, which are reported to have passed into the hands of a French company that proposes to add a steel plant, with which it expects to make steel rails, tires, axles, and other railway material.

Nijni-Novgorod.

Jonooskopf & Mendeleieff.

In the Nijni-Novgorod district new iron works were established in 1875, by Jonooskopf & Mendeleieff, consisting of a blast furnace, 42 feet high, blown with a horizontal engine, puddling and reheating furnaces, and a train of merchant rolls.

In April, 1876, a new establishment for the manufacture of wrought-iron pipes was started at St. Petersburg. The great central market for the sale of iron in Russia is Nijni-Novgorod.

Ownership of works.

Many of the iron and steel works of Russia are owned in whole or in part and directly or indirectly managed by the government. Some of the enterprises already mentioned are thus owned and controlled. A few others may be mentioned, some of great antiquity.

Blast-furnaces in the district of Blagodat.

In the district of Blagodat, in the province of Perm, are situated the Kushwinsk blast-furnaces, commenced in 1735; the Verkhni-Turinsk furnaces, which date from 1737; the Baranchinsk furnaces, which date from 1743; the Nijni-Turinsk iron works, founded in 1766, and which produce

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RUSSIA.

annually about 2,200 tons of bar and sheet iron and boiler plate; and the Serebranskii works, established in 1784, which make about 800 tons of finished iron, 1,000 tons of puddled iron, and 650 tons of steel annually. The Serebranskii works are driven by ten water-wheels, and have four Siemens furnaces and three trains of rolls.

Iron-works in the district of Blagodat.

At the Knase-Michailovski Works, in the mining district of Zlatoust, province of Ufa, is a very extensive manufactory of cannon and small-arms, founded in 1771, which includes a steel department of large and varied capacity.

Knase-Michailovski Works.

Cannon and small-arms.

The Satkinsk Works, in the same district, established in 1756, produce pig-iron.

Satkinsk Works.

The Watkinskii Works, founded in 1759, annually make about 1,000 tons of wrought iron, 100 tons of chains, 1,000 tons of rails, and 500 tons of steel.

Watkinskii Works.

The Kamskii Works, in the province of Perm, founded in 1862, annually produce about 500 tons of armor plates, and other heavy iron for ship-building purposes, and employ 850 workmen.

Kamskii Works.

In Olonetz and Finland are the Alexandrovskii Works, founded in 1772, which constitute a gun and projectile foundry; the Koncheoserkii furnace, dating from 1707; the Suojarvi furnace, owned by the government since 1856; and the Valaasminskii furnace. These furnaces use lake or bog ore, as do most of the Finnish furnaces.

Alexandrovski Works.

At Slawkaw, in Russian Poland, are government works which produce sheet-iron; and at Panki, also in Poland, is a government blast furnace.

Slawkaw, Poland.

In addition to the various iron and steel enterprises here enumerated, there are other extensive works in the Ural Mountains, in Finland, and elsewhere, but sufficient details have been given to show the progress that Russia has made in the introduction of modern processes of iron and steel manufacture. Her pig-iron was eagerly purchased by England and other countries two centuries ago, because of its exceptional excellence, and her sheet-iron, made by a process peculiarly her own, has long challenged the admiration of the world.

Sheet-iron.

Iron and steel statistics.

Iron and steel statistics.

The accessible statistics of the iron and steel industries of Russia do not come down to a later period than 1875. In that year there were produced 426,896 metric tons of pig-iron and furnace castings, from 913,607 tons of iron ore; 243,126 tons of bar-iron, rails, etc.; 60,693 tons of plates and sheets; and 12,928 tons of steel. The quantity of iron ore mined in 1875 amounted to 1,063,831 tons. In 1866 the

In 1875.

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RUSSIA.

Iron and steel statistics.

production of iron ore was 581,771 tons. In 1830 the production of the blast furnaces amounted to 183,104 tons; in 1860, to 297,937 tons; and in 1870, to 359,989 tons. In 1860 the production of wrought iron was 183,735 tons, and in 1870 it was 251,582 tons. In 1860 the production of steel was 1,051 tons, and in 1870 it was 8,788 tons. The production of iron ore, pig-iron and castings, wrought iron, and steel, respectively, was greater in 1875 than in any preceding year.

Furnaces in 1873.

In 1873 there were in Russia 245 blast furnaces, 522 puddling-furnaces, 700 reheating-furnaces, 20 puddling and reheating-furnaces, 840 refinery furnaces, 472 steel furnaces, 191 cupolas, and 88 air-melting furnaces.

In 1876.

In 1876 the number of blast-furnaces in Finland was 21. In this district and in other portions of Russia the furnaces are small, and at nearly all of them water-power is used. With scarcely an exception, charcoal is used as fuel. A great deal of iron is still refined in Russia in Catalan forges and blomaries, and by other primitive methods. The fuel used is charcoal, and power is obtained from the mountain streams.

Survival of primitive methods.

Charcoal fuel.

Coal-mining districts.

The mining of coal in Russia is mainly confined to the districts of Donetz, Vistula, and Moscow, although coal is found in several other localities. The Donetz district is in the Donetz Mountains in Southern Russia, and is one of the most extensive in Europe; it contains both anthracite and bituminous coal, much of it of good quality. The Moscow district is in Central Russia, and the Vistula district is in Russian Poland.

Output.

The total production of all the coal fields of Russia was 437,625 metric tons in 1867, and 1,709,269 tons in 1875. Of the production in 1875, the Donetz district yielded 842,558 tons; the Moscow district, 387,538 tons; and the Vistula district, 407,935 tons. The methods employed in the mining of Russian coal are not usually the best that science and economy would suggest, but that great progress is being made in its development is shown in the greatly increased production from 1867 to 1875. Incomplete statistics for 1876 show a production in that year approximating 2,000,000 metric tons. The coal in the neighborhood of Moscow is largely lignite, but of good quality.

Imports of iron and steel.

The imports of iron and steel and of machinery into Russia are large, indicating that if there has been overproduction of these products in other countries, there has certainly been none in this. In 1875 there were imported, principally from Great Britain, 57,464 metric tons of pig-iron, 87,705 tons of bar-iron, 58,126 tons of iron rails, 111,554 tons of steel rails, 31,031 tons of hoops, sheets, etc.,

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RUSSIA.

3,813 tons of plates, and 19,638 tons of steel. Since 1875, however, the iron and steel industries of Russia have been greatly stimulated, and the imports of 1875 have not been maintained, although still large, owing to the pressing exigencies created by the war of 1877–'78 with Turkey. In 1878 four iron vessels and forty locomotives were purchased in the United States. This country has also supplied large quantities of agricultural implements to Russia, but Great Britain has been an active competitor in this field. The imports of coal into Russia amounted to 1,497,214 metric tons in 1876, Great Britain, Germany, and Austria supplying all. The Finnish furnaces are partly supplied with ore from Sweden.

Imports of iron and steel.

American iron vessels, locomotives, and agricultural implements.

If the published statistics of Russian exports are correct, the exports of iron amounted to 14,062 metric tons in 1876, and to 1,145 tons in 1877, while the exports of steel amounted to 71 tons in 1876. The exports of coal in 1876 amounted to only 565 tons.

Exports.

SWEDEN.

SWEDEN.

This most interesting country made a splendid display at Paris of its iron and steel resources, as it has done at all recent international exhibitions. No better iron is made in the world than is made by Sweden, with native ores and charcoal fuel; and, having to rely mainly upon other countries to consume what she produces, she would have been faithless to her own interests if she had not exhibited samples of this iron upon every suitable occasion. But she has not been satisfied merely to exhibit these samples; she has arranged them with the utmost taste and care, giving them a really artistic embellishment, which has not, however, imparted to them a gaudy and offensive prominence; and, to still further heighten the effect and add to the value of their display, she has distanced all her rivals in the enterprise and tact she has shown in printing and circulating, in many languages, exhaustive descriptions of her metallurgical resources, of the methods employed in their utilization, of the capacity of her manufacturing establishments, and of the character of their products. No American who visited the Philadelphia Exhibition can forget the Swedish iron and steel exhibit or the great work of Professor 'Akerman, which was freely distributed, "On the State of the Iron Industry in Sweden." At Paris similar taste and similar enterprise were displayed. The Swedish iron and steel exhibit was, in every respect, magnificent. The display of Swedish machinery and tools and cutlery was also very creditable, but it was not large. The machinery display was not so large as that of Belgium,

No better iron than Swedish.

Valuable exhibit.

Information circulated.

Centennial exhibit.

Prof. Akerman.

Machines.

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SWEDEN.

which is a much smaller country and lacks Sweden's metallurgical resources.

Iron and steel exhibits.

Iron and steel exhibits.

The Swedish iron and steel exhibit comprised all the raw materials and finished products the country produces.

Motala Company, ores, iron, manufactures of iron and steel.

The well-known Motala Company was the principal exhibitor. There were many specimens of the rich magnetic, specular, hematite, and other ores of the country; specimens of pig-iron, speigeleisen, bar-iron, rods, wire, billets, and nails; Bessemer, crucible, and Siemens-Martin steel; steel and iron plates; wrought-iron car wheels, etc. Some of the specimens were twisted, bent, and fractured to show their quality. The Swedish Iron Board showed Bessemer and Siemens-Martin plates and also iron plates, all of which had been subjected to comparative tests which established the superiority of those made of steel. In machinery there were various wood-working machines of ordinary excellence; a Bessemer steel marine boiler; a couple of vertical engines, and a few other good engines.

Swedish Iron Board. Plates, engines, and machine tools.

J. & J. C. Bolinder. Saw-mills, tools, stoves, etc.

J. & J. C. Bolinder, of Stockholm, exhibited saw-mill machinery, circular saws, and a large collection of stoves and furnaces. The display of agricultural implements and machinery was neither large nor noteworthy; but a better display could not, perhaps, have been justly expected, as Sweden is not greatly favored in its agricultural capabilities. The articles exhibited were not, as a rule, light and graceful and "handy," like their American rivals.

Cutlery.

In tools generally Sweden showed to better advantage, and in knives, razors, scissors, and other cutlery there was a small but creditable display.

Of railway appliances the display was small, and not specially remarkable.

Comparison of Swedish iron;

It is a fair criticism of the entire Swedish exhibit of iron and steel to say that the quality of the articles shown was not excelled in the Exposition, and that in extent and variety they were excelled only by Great Britain, France, and Belgium; and it is also a fair criticism of the machinery, tools, and other iron and steel articles exhibited to say that they indicated that Sweden has not made the same progress in the reproductive arts associated with the iron and steel manufacture that has been made by Great Britain, the United States, France, Germany, Belgium, and Austria. A stranger cannot well understand why a people so intelligent and skillful as the Swedes, and possessed of their resources, should have so generally limited their energies to the pro-

and of Swedish manufactures.

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duction of crude or half-manufactured iron and steel products, excellent and unsurpassed as they are.

Iron and steel production.

Iron and steel production.

The principal iron-ore deposits of Sweden are found in the district lying immediately north of Lakes Wenner and Wetter, and northwest of Stockholm. Here are located a majority of the blast furnaces and finished iron and steel establishments of Sweden. The ores found in this district are principally magnetic. Iron ore is, however, found in almost all parts of the kingdom, and in Lapland there are immense deposits of magnetic ore which have remained practically undeveloped because there has been no great scarcity of good ore elsewhere in Sweden. The rock or mountain ores of Sweden are almost free from phosphorus, and many of them are rich in manganese. They are therefore well adapted to the production of Bessemer steel, in the manufacture of which Sweden was the first country in the world to win complete success, but in which she has not recently borne a prominent part. The pig-iron intended to be converted into Bessemer steel is produced in charcoal furnaces, and from them is run direct, without exception, into the converters, which are of from 2 to 4 tons capacity. The ore and the fuel both being of the best quality, the steel produced is in every respect superior. I am reminded by Professor Akerman that at the Paris Exposition of 1867 Sweden exhibited the finest razors and similar wares of Bessemer steel, and that in the manufacture of cutlery in Sweden this metal is now almost exclusively employed. At the Bessemer steel works powerful blowing engines are used, and with one exception (Sandviken) they are all driven by water-power. The early converters are all stationary, but a majority of the Bessemer works have movable converters. Some of the ores used in the production of Bessemer steel are so rich in manganese that the addition of spiegeleisen in the converter is not necessary. This is also prominently the case with the Altenberg spathic ores, which are used in the manufacture of pig-iron by the Neuberg work in Styria, in Austria, and from which the celebrated Neuberg Bessemer steel is obtained. Such spiegeleisen and ferro-manganese as are needed in the manufacture of Swedish steel are easily produced.

Ore districts.

Magnetic ores.

Mountain ores

Superior Bessemer steel.

Cutlery of Bessemer steel.

Ores rich in manganese.

Neuberg Bessemer steel.

The magnetic and specular ores of Sweden, called mountain ores, are appropriated to the production of wrought iron and steel, and the ores found in the lakes and bogs, which are chiefly obtained in one province (Småland), are mainly

Mountain ores.

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SWEDEN.

used in the production of foundry iron. The latter ores contain phosphorus. The blast-furnaces of Sweden were built about 30 feet high until within the last few years; modern furnaces are from 40 to 55 feet high, and from 7 to 10½ feet wide at the boshes. Pine and spruce charcoal is almost exclusively used as fuel in the blast furnaces, wood and brushwood being sometimes mixed with it, and occasionally a little coke. It need scarcely be added that the Swedish method of preparing ores for the furnace and the subsequent treatment of them are painstaking in the extreme, securing great excellence and uniformity of product. The production of the furnaces ranges from 30 to 120 tons a week. Almost without exception blast is supplied by water-power. Wrought iron is usually obtained by refining pig-iron in Lancashire hearths, and subsequently hammering or rolling the blooms. The Lancashire process was introduced from England about 1830 by Gustaf Ekman, a distinguished Swedish iron-master. The Franche-Comté process, which is a modification of the Lancashire process, is used at some of the smaller works, and at still other works, in Dannemora, the Walloon process is used. Other refining hearths may yet be found in Sweden, but are not much used. All these are but modifications of the ordinary bloomary process. Catalan forges, for the reduction of ore directly to wrought iron, have been abandoned in Sweden, but the other methods, just mentioned, which have been generally superseded by puddling furnaces in other iron-making countries, are still popular with the Swedes. In the Lancashire, Franche-Comté, and Walloon process charcoal is the only fuel that is used. Puddling is done at only a few works, chiefly with imported coal, but air-dried pine wood is used at two works, and at Motala and Surahammar regenerative gas-furnaces for peat have been successfully introduced.

Blast-furnaces.

Fuel.

Careful methods, with excellence and uniformity of product.

Refining hearths.

Lancashire process.

Franche-Comté process.

Walloon process.

Catalan forges.

German steel has long been made in Sweden, and small quantities are still made. Puddled steel is made at two works. The manufacture of steel in crucibles by the Uchatius method is in operation at Wikmanshyttan; crucible cast steel is also made at Österby, in a Siemens-Lunden furnace, with wood as fuel. Since 1868 the open-hearth process has been in use at Munkfors, where the works of the Uddeholm Company are located, and since that year other works have adopted it. A Pernot furnace has been erected at Boxholm. In 1876 there were 19 Bessemer works in Sweden, but some of them were not then at work, and the producing capacity of nearly all of them was small.

German puddled and crucible steel.

The primitive methods of iron manufacture which have

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SWEDEN.

been mentioned have become deeply rooted in the affections of the Swedish people, and partly to this preference, partly to the absence of mineral fuel for the generation of steam and for other purposes, partly to the absence of restrictive duties on foreign iron and steel and iron and steel products, and partly also to the scarcity of capital and the insufficiency of railroad and canal transportation, may be attributed the slow progress made by Sweden in increasing the production of her iron, which was famous for its excellence before a pound of iron was made in the United States, and even before prophecy had foretold for England her marvelous career in supplying the world's demand for iron and steel. These primitive methods are so generally adhered to to-day that, even if the other influences named were essentially modified, the production of iron and steel in Sweden would not increase very rapidly. A few large-coke furnaces, supplied with fire-brick hot-blast stoves and powerful blowing engines, would double the production of pig-iron, but they will not soon be built, although coke might easily be obtained from England or Germany. One Bessemer establishment such as we have in the United States would double the production of Bessemer steel, but the Swedes have no present use for it. Quality, not quantity, is their motto, and it is a good one; but they might have both if they would. They ought, at least, to have supplied their own iron and steel wants, which, remarkable as it may seem, they have not done for many years.

Primitive iron and steel processes.

Early Swedish celebrity.

Reasons for the slow progress of Swedish iron and steel industry.

Quality, not quantity.

The works of the Motala Company are the most important in Sweden. They comprise five distinct establishments: (1) The works at Motala; (2) the Motala ship-yard at Norrköping; (3) the Lindholmen ship-yard and machine-shops; (4) the Nyköping works; (5) the Bängbro iron and steel works. Plates, bars, tires, gun-bands, railway-wheels, locomotives, castings, and Bessemer and Siemens-Martin steel are among the products of the various works. The Motala is a limited company, with 800 shares, the aggregate par value of all of which is about $1,100,000. In 1874 there were paid by this company for labor and materials about $2,000,000, exclusive of the Bängbro works. Other large works are those of the Fagersta, Sandviken, Surahammar, and Uddeholm companies.

Motala establishments.

Products.

Very few iron rails are made in Sweden, and still fewer steel rails. There is but little local demand for the latter, and they cannot be manufactured so cheaply as to permit of their exportation. The iron rails used are chiefly imported, the Swedes preferring to put their good iron into other forms

Rails.

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SWEDEN.

Questionable tariff policy.

and buy "cheap" British and Belgian iron rails, upon which they impose no duty. It may be safely assumed that so long as this policy is continued neither the iron nor the steel rail trade of Sweden will prosper. Before 1870 no rails of any kind were made in Sweden. Wrought-iron railway-wheels, railroad-axles of steel and iron, steel tires, nails, wire, and other iron and steel products are manufactured in small quantities; but here again production and prosperity are less than would exist if import duties were higher than they are.

Importation of railway supplies.

In the manufacture of locomotives and railroad cars Sweden does not supply her own wants.

Coal.

Coal.

In the southwestern part of Sweden, opposite "The Sound," in a district of country of which Helsingborg is the principal town, is found the only coal deposit thus far discovered in the kingdom. The coal is of an inferior quality, and the annual product has never amounted to 100,000 metric tons; it was 92,352 tons in 1876. It seems probable that Sweden will never greatly increase this product, but British and German coal are so near at hand that the absence of native coal is not a serious drawback to those industries on or near the sea-coast which require mineral fuel in the production of steam, or are otherwise best promoted by its use. The imports of coal and coke are annually increasing. In 1855 they amounted to only 135,652 metric tons; in 1876 they had reached to 946,092 tons, Great Britain supplying almost the entire quantity. Since 1876 Germany has made a determined effort to supply the Scandinavian countries and Russia with her Westphalian coal.

Importation of British and German coals.

Iron and steel statistics.

Iron and steel statistics.

Ore production.

The production of iron ores in Sweden was 417,337 metric tons in 1860, of which 395,111 tons were mountain ores, and 22,226 tons were lake and bog ores. In 1874 the production was 926,825 tons, when the maximum was reached, of which only 4,300 tons were lake and bog ores. In 1876 the production of mountain ores fell to 787,461 tons, while that of lake and bog ores increased to 9,000 tons. The exports of Swedish ores are mainly to Finland, amounting to 25,310 metric tons in 1874, and in 1876 to 14,920 tons. The imports of iron ore are only nominal, amounting in 1874 to only 191 metric tons, probably from Norway.

Blast-furnaces.

In 1875 there were 325 blast furnaces in Sweden, of which 224 were in blast and 101 were out of blast. In 1876 there were 205 in blast, which produced 344,834 metric tons of

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SWEDEN.

pig-iron. The production of pig-iron in 1860 was 179,897 metric tons; in 1870 it was 293,253 tons; and in 1873 it was 339,685 tons. The production of castings from the blast-furnace has increased since 1860, when it was 5,237 metric tons; in 1376 7,788 tons were produced. In 1875 there were produced 17,331 tons of castings in 61 foundries; 189,845 tons of wrought iron were produced with 770 furnaces and fires in 33 works; and 21,385 tons of Bessemer, open-hearth, and other steel were produced in 33 steel works, of which 19,370 tons were Bessemer steel. The total production of rails in 1875 was 2,893 tons; of plates and sheets, 9,077 tons; of wire and nails, 8,313 tons; of tools, 1,847 tons; of "other hardware," 16,110 tons.

Pig-iron.

Castings.

Wrought-iron and steel.

Products in iron.

The imports of iron and steel, machinery, tools, and cutlery into Sweden, principally from Great Britain, aggregated 88,355 metric tons in 1875, of which 55,099 tons were rails, and 17,924 tons were pig-iron. The total value of the imports was £1,628,386, of which £824,938 represented "machines and tools," not including steam-engines and edge-tools. In 1875 the imports of iron and steel amounted to 65,893 tons, of which rails formed just one-half. The exports of iron and steel, etc., from Sweden in 1875 amounted to 204,752 metric tons, of which 106,393 tons were bar-iron; 48,742 tons were pig-iron; 12,439 tons were blooms; 20,049 tons were hoop, bulb, and "other iron;" and 6,273 tons were "raw steel." The value of the exports was £2,512,549. In 1876 only 174,862 tons were exported. It is plain that Sweden does not derive the benefits from her valuable iron resources that she might. She imports almost half as much iron and steel and their products as she exports, and pays for the articles she imports more than half the money she receives for her exports. Greater diversification of her mechanical industries, greater persistence in those for which she possesses special facilities, a wider acceptance of modern metallurgical methods, an increase of her 2,500 miles of railroad to at least 5,000 miles, and a protective tariff are the great needs of the iron and steel industries of Sweden.

Imports of iron and iron manufactures:

Value.

Exports:

Value.

Needs of Sweden.

UNITED STATES.

UNITED STATES.

The United States is the last to be mentioned of the eight countries named in a preceding table which produce more than ninety-eight and a half per cent. of all the iron and more than ninety-nine per cent. of all the steel made in the world; but it is the second in rank among these countries.

Second in rank of iron and steel-producing countries.

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UNITED STATES.

Absence of exhibits at Paris.

Inadequate display of our resources and products.

As has been already stated, the whole display made by the United States at Paris was inadequate and not fairly representative of the industrial resources and progress of our country. This remark is especially applicable to the display of iron and steel and their products. The great rolling-mills and steel works of the country literally made no sign of their capabilities, and our equally great blast-furnaces and machine shops were scarcely represented, and our cutlery and tool manufactories but partially. It is not merely a familiar rhetorical pleasantry to say that the products of all these establishments were conspicuous by their absence, for their presence in force had been expected, and with reason. The Philadelphia Exhibition had taught the world that the United States had developed unsurpassed enterprise, and skill, and resources in the production of all kinds of iron and steel, and machinery, cutlery, and tools, and surely it was not to have been expected that the manufacturers of these products would so generally ignore another world's fair two years later. To be more specific, it may be frankly stated that absolutely nothing was exhibited by the various steel works of the country, nor by the rail, bar, plate, sheet, hoop, and wire mills. Not a rail, nor a bar of iron, nor an ingot of steel of American manufacture was on exhibition, and only a few kegs of cut nails. The large locomotive works of the United States were represented by one locomotive; the manufacturers of steam fire-engines sent only one engine; the manufacturers of machine tools sent almost nothing; there was but one exhibit of pig-iron and but two or three exhibits of iron ores; no American railway freight car was on exhibition; there was but one exhibit of American anthracite coal, and none whatever of our unequaled Connellsville coke. Of bituminous or semi-bituminous coal from the great coal basins of the country, West Virginia made the only display. We sent but few stoves, although we make the neatest, cheapest, and best stoves in the world. An unpleasant subject may be dismissed with the summary statement that a great opportunity to deepen the good impression made at Philadelphia by our iron and steel manufacturers, and by our manufacturers of heavy machinery, and of cutlery and tools, and to reap the fruits of that impression, was almost wholly lost at Paris—lost because our own government delayed too long the acceptance of the invitation by the French Government to participate in the Exposition, and because when the invitation was accepted sufficient money was not appropriated to

The promise of our Centennial not realized in Paris.

The products of our steel-works and iron-mills not exhibited.

One locomotive, one fire-engine.

Few ores, coal, and stoves.

Lost opportunity of deepening the impression made by the Centennial Exhibition.

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enable manufacturers to make a proper display of their products. UNITED STATES.

Iron and steel exhibits.

The Barnum Richardson Company, of Lime Rock, Conn., made a very fine exhibit of Salisbury iron ores, charcoal pig-iron, and chilled car wheels. Samples of the pig-iron and some of the car wheels were broken to show their quality. Some of the Salisbury wheels of exceptional excellence have made the following mileage record on the Lake Shore and Michigan Southern Railroad: 4 wheels averaged 185,049 miles; 2 averaged 220,528 miles; 2 others averaged 198,967 miles; 3 averaged 189,397 miles; 6 averaged 175,203 miles; and 4 averaged 168,979 miles. Barnum Richardson Co. Mileage record of Salisbury wheels.

The Lobdell Car Wheel Company, of Wilmington, Del., also made a very creditable display of chilled car wheels, and of chilled-iron rolls for calendering paper and for other manufacturing purposes. The company also submitted printed statements showing the amount of service performed by some of the wheels of its manufacture. One wheel had been twenty-five years in service on the New York and Erie Railroad, and is supposed to have run a million miles; other wheels had been in use on the Philadelphia, Wilmington, and Baltimore Railroad over twenty years, but their mileage is not known. From 50,000 to 80,000 miles is a common record for the Salisbury and Lobdell car wheels to make. Lobdell Car Wheel Co. Mileage of wheels.

The paper-making rolls exhibited by the Lobdell Company attracted great attention; they were smooth and perfectly true, and the chill was of a depth with which European founders are unfamiliar. They were polished like silver. Calender rolls

Whitney & Sons, of Philadelphia, exhibited chilled car wheels of their make which suffered nothing by comparison with the exhibits of the other manufacturers mentioned. Some of the wheels were broken to show the quality of the iron and the depth of the chill. A wheel was exhibited by this firm which had traveled 120,000 miles under the tank of a locomotive, and was fit for further service. Chilled car wheels are not a novelty in Europe, but they are not generally in use, except perhaps in Austria, and it was gratifying to see three of our leading car-wheel manufacturers so mindful of the opportunity presented to them at Paris to add to the popularity of American wheels. Our exports of these wheels may be largely increased with a little effort. Whitney & Sons. Car-wheels.

Samples of iron and steel produced by the direct process of C. M. DuPuy, of Philadelphia, were exhibited by Philip S. Justice, of the same city. Mr. DuPuy has since been Direct process of C. M. DuPuy.

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called to Europe to explain his process. Morris, Wheeler, & Co., of Philadelphia, exhibited samples of their cut nails; and Hoopes & Townsend, of the same city, exhibited complete and handsome samples of their nuts, bolts, screws, rivets, and washers. The nuts manufactured by this firm are made by machinery and punched cold, and are perfect in every respect.

Morris, Wheeler, & Co.

Hoopes & Townsend.

Machine-made horseshoe nails, bright and well proportioned, were exhibited by the Globe Nail Company, of Boston.

Globe Nail Co.

Aiken & Drummond, of Louisville, Ky., exhibited an ingenious machine for making molds for all kinds of fine and other metal castings.

Aiken & Drummond.

Scales for mines, foundries, furnaces, rolling-mills, railroads, and miscellaneous uses were exhibited by the Fairbanks and the Howe Scale Companies, of Vermont, and formed the finest display of the kind at the Exposition.

Fairbank's and Howe's scales.

The American display of machinery and machine tools was not large, as has already been stated. Very heavy mining, excavating, lifting, and manufacturing machinery was wholly wanting, but the model of a machine for mining coal was exhibited by the Lechner Mining Machine Company, of Columbus, Ohio. No machinery whatever for making iron or steel was exhibited.

Lechner coal-mining machine.

Of cotton, woolen, and silk manufacturing machinery the only exhibits were the Jacquard loom of Tilt & Son, of Paterson, N. J., and a circular loom for weaving multiply fabrics, exhibited by J. V. D. Reed, of New York.

Looms of Tilt & Son and J. V. D. Reed.

There were several steam-engines, of various forms of construction, on exhibition, and, as already stated, one locomotive—the last exhibited by the Philadelphia and Reading Railroad Company, which also exhibited the only sample of American anthracite coal I observed at the Exposition.

Philadelphia and Reading Railroad Company.

An engine of the Corliss type, with improved valves and valvular arrangement, was exhibited in motion by Jerome Wheelock, of Worcester, Mass., and attracted much attention from experts.

Jerome Wheelock; steam-engine.

A sample of bituminous coal from the Indian Territory and other small samples of the same kind of coal from the Pacific coast were exhibited.

Pacific coal.

Among the machine tools exhibited was the Blake stone and ore crusher, and a very fine collection of the machines of the Brown & Sharpe Manufacturing Company, of Providence, R. I. Bliss & Williams, of New York, and the Saint Louis Stamping Company also made noticeable dis-

Brown & Sharpe.

Bliss & Williams.

Saint Louis Stamping Company.

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plays of their stamping-machines, and the former firm exhibited other metal-working machines.

In the class of railroad apparatus there were exhibited, in addition to the articles already mentioned, samples of car springs, by the National Car Spring Company, of New York; a street railway car, by J. G. Brill, of Philadelphia; three cars of the same description, by the John Stephenson Company, of New York; one model of a sleeping-car and one full-sized sleeping-car, by the Pullman Palace Car Company, of Chicago; and automatic air-brakes, by the Westinghouse Air Brake Company, of Pittsburgh.

National Car-wheel Company.
J. G. Brill.
John Stephenson Company.
Pullman Palace Car Company.
Westinghouse.

The Collins Company, of Hartford, Conn., and the Douglas Axe Manufacturing Company, of Boston, exhibited axes, hatchets, and other edge-tools, which justly received much attention, and were in the highest degree creditable to our country.

Collins Co.
Douglas Axe Company.

Several firms exhibited carpenters' tools, and other firms exhibited garden tools and agricultural implements, such as rakes, hoes, shovels, forks, etc. Oliver Ames & Sons, of North Easton, Mass., made a fine display of shovels and spades. The excellence of American rakes, hoes, forks, shovels, etc., is everywhere recognized in Europe, where many of them are in use.

Oliver Ames & Sons.
Agricultural tools.

Files and rasps were exhibited by McCaffrey & Brother, of Philadelphia; and the Russell & Erwin Manufacturing Company, of New Britain, Conn., showed a full collection of its celebrated specialties. Tacks and nails were exhibited by A. Field & Sons, of Taunton, Mass.; and pumps, hydrants, hydraulic rams, etc., by W. & B. Douglas, of Middletown, Conn.

McCaffrey & Brother.
Russell & Erwin.
A. Field & Sons.
W. & B. Douglas.

The only display of American saws was made by Henry Disston & Sons, of Philadelphia, and it not only elicited the hearty praise of all who saw it, but it was generally recognized as the best exhibit of the kind at the Exposition.

Disston & Sons.

J. A. Fay & Co., of Cincinnati, Trump Brothers, of Wilmington, Del., and others, exhibited wood-working machinery.

J. A. Fay & Co.
Trump Bros.

Machines for making boots and shoes, for crimping leather, and for sewing were exhibited, and served to illustrate not only the inventive genius of the American people but the extensive use which their general adoption of labor-saving machinery has created for iron and steel in the United States.

Boot-making and leather machinery.

The display at Paris of American agricultural machines —mowers, reapers, threshers, binders, etc.—was in all respects creditable. It is not my province to enter into par-

Agricultural machinery.

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UNITED STATES.

ticulars concerning it, or concerning the triumphs of American agricultural machines at the competitive trials which took place in France during the summer; but I could not pass without notice such a magnificent collection of labor-saving inventions, to the neatness, completeness, lightness, and success of which American iron and steel have so greatly contributed.

Comments of the London "Times" on American machinery.

Imperfect and unsatisfying as was the American mechanical display at Paris, it nevertheless was sufficiently meritorious to elicit from that great exponent of European and especially English public opinion, the London "Times," the highest measure of praise. Whole columns were devoted by it last summer to eulogizing American mechanical genius and its productions. It may not be inappropriate that I should close my reference to the American display at Paris by quoting from the "Times" of August 22, 1878, the following brief paragraphs:

"Times" of Aug. 22.

Stow flexible shaft.

"Finest type of the Yankee contrivance is the Stow 'flexible' shaft for transferring power round corners and to out-of-the-way places. One sees the operator holding what seems at first sight to be a small garden hose, but furnished with an auger at its extremity, with which he thrusts and bores in every direction—over his head, under his feet, to the right, to the left—it upsets all one's ideas of rigidity. Pharaoh could not have been more surprised at seeing Moses's rod turn to a serpent than we were to see this rope-like affair eating into the planks set on all sides for it to work on. It is as good as a piece of legerdemain. It is really a 'flexible shaft'—a cable of steel wires wound coat over coat, each successive coating in the reverse direction from the preceding, until the strength required is attained, and in which longitudinal flexibility is combined with circumferential rigidity.

Clough and Williamson's cork-screw machine.

"Close by it stands Clough & Williamson's 'wire cork-screw machine,' which catches a straight piece of steel wire and throws it out a cork-screw of such temper that it may be driven through an inch deal plank and not yield a hair's breath. The deftest waiter will take as long to pull a cork as this machine to make half a dozen cork-screws of an exceptionally good quality.

Screw-cutting machine.

"Here is a screw-cutting machine, which takes a rod of iron, steel, or brass, and by an automatic series of operations drops screws at the other end of the machine. One tool cuts the point of the rod down to the dimensions of the screw, another cuts it off, having the head the full size of the rod, another takes it from the last and passes it on to have the thread cut, a cutter passes by and leaves it slotted, another with four iron fingers takes it and transfers it to a fifth cutter, where the head is finished, when still another tool comes to push it into the pan placed to receive it. No intervention is needed until another rod is wanted.

Shoe-making machines.

"A set of shoe-making apparatus in another inclosure takes the leather in the hide and turns out, with slight manual application, a pair of shoes, sewed, pegged, or screwed, in about 15 minutes."

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The manufacture of iron in the colonies which now form the Atlantic portion of the United States commenced immediately after their first settlement by the English about the beginning of the seventeenth century. At first bog ores were used, and, although other and more valuable ores were soon afterwards discovered and used, it is worthy of remark that the use of bog ores continued in New England down almost to the middle of the present century. The first iron enterprise in the colonies was undertaken on Falling Creek, in Virginia, in 1619, but it ended disastrously in 1622, the Indians destroying the works, which were most probably forges. This enterprise was not revived. In 1643 a blast furnace was successfully established at Lynn, in Massachusetts, and in 1651 a forge was added at the same place. Soon afterwards other iron enterprises were established in Massachusetts, Rhode Island, and Connecticut. About 1734 the development of the celebrated Salisbury iron-ore district of Connecticut was commenced by Thomas Lamb, who erected a forge at Lime Rock. Soon after 1664 iron was made at Shrewsbury, in New Jersey, by Henry Leonard, and in 1682 it is recorded that a forge and blast furnace were in existence at this place. Experiments in the manufacture of iron in Pennsylvania date from 1692, but iron was not successfully made until 1717, when Thomas Rutter built a forge on the Manatawny Creek, near Pottstown. Other iron enterprises in Pennsylvania soon followed. About 1715 the manufacture of iron was revived in Virginia at Fredericksburg and commenced in Maryland at Principio, in Cecil County. The Carolinas made iron about the same time. Iron was made in New York about 1740, on Ancram Creek, in Columbia County. No iron was made in Georgia until the present century.

Forges in Virginia in 1619.

Lynn, Massachusetts, 1643.

Salisbury district, Conn., 1743.

Shrewsbury, N. J., 1664.

Pottstown, Pa., 1717.

Fredericksburg, Va., 1715.

Ancram Creek, N. Y., 1740.

Early in the eighteenth century the exportation of iron from the colonies to England commenced, the scarcity of timber for charcoal preventing that country from making a large quantity of pig-iron. Small quantities of bar-iron were shipped in 1717 and 1718, and were followed by other shipments down to the Revolution. In 1728 and 1729 the colonies exported 1,156 English tons of pig-iron to England; and annually thereafter down to the Revolution pig-iron was regularly exported to England and Scotland. The shipments of bar-iron and pig-iron never reached large proportions, aggregating only about 50,000 tons of bar-iron and 150,000 tons of pig-iron from their commencement to the Revolution. The iron industry in the colonies was, however, so fully established

Exportation to England,

1717.

1728.

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that it supplied the home markets, which was a more important matter than the building up of a great export trade. When the war for independence came, success would have been impossible if the colonists had not been able to supply themselves with home-made iron for all warlike purposes.

Home-made iron in the War of Independence.

When the war for independence was over, the American iron industry took a fresh start in many of the States, especially in Pennsylvania, and many furnaces and forges were built, charcoal being the only fuel used. But the general use of coke in the blast furnaces of England and the introduction in the same country of puddling furnaces and grooved rolls, and the application of steam to rolling mills and blast furnaces, about this time wrought a great change in the English iron manufacture, and through these improvements and the very low duties levied in this country on all imported iron England was enabled to contest with considerable success the possession by the States of their own iron markets. This formidable foreign competition had the effect in time of greatly retarding the development of the domestic iron industry. Notwithstanding the steady development of the country in other directions, its iron industry made but slow progress. In 1810 the total production of pig-iron was only 54,000 tons, and of bar-iron only 24,541.

Use of coke and improved machinery in England.

English competition.

United States production in 1810.

1820. 1828. 1832. 1842. 1846. 1852.

1820. tons. In 1820 the production of pig-iron had fallen to 20,000
1828. tons; but in 1828, owing to the passage in 1824 of a high
1832. tariff, it rose to 130,000 tons, and in 1832, in consequence of the continuance of the policy of 1824, it reached 200,000 tons. But in 1833 a reactionary tariff policy was adopted, which
1842. continued until 1842, in which year the total production of pig-iron was but slightly in excess of that of 1832, being
1846. 215,000 tons. From 1842 to 1846 high duties again prevailed, and in the latter year the production reached 765,000 tons. To this increase the influence of mineral fuel, which had been recently introduced, in part contributed. In 1846 duties were again reduced, with the result that, notwithstanding the use of mineral fuel, for a year or two production remained stationary and then commenced to fall, dropping in 1852 to 500,000 tons. From this time forward until 1860 the iron industry of the country very slowly advanced, despite the continued adherence of the government to a policy of low duties. It was fortuitously aided by the discovery of gold in California and Australia, which quickened business and commercial enterprise throughout the world; by the Crimean war, which created a sudden demand for British iron and advanced its price; and by the rapid growth from 1850

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UNITED STATES.

to 1860 of the railway system of the United States. Notwithstanding these favorable influences, the production of pig-iron only increased from 500,000 tons in 1852 to 821,223 tons in 1860. Protective duties were restored in 1861, but the depressing influences of the civil war in that and the following year reduced the production of iron below that of 1860. In 1863 and 1864 the wants of the government and the beneficial influences of the tariff of 1861, unitedly caused a production of 1,014,282 tons of pig-iron in the latter year, from which there was a decline during 1865, when the war closed. After 1865 the production of all kinds of iron, and of steel also, rapidly increased, the stimulating effects of the tariff of 1861 being now everywhere perceptible, but the abundance of money and the fever for building railroads forming yet more potent influences in securing this increase. In 1872 the production of pig-iron reached the very large quantity of 2,548,712 tons, and in 1873 even this product was slightly exceeded, 2,560,962 tons being then produced. But from 1873, when the financial and railroad panic occurred, until 1876 the production of pig-iron gradually declined to 1,868,960 tons. In 1877 it increased to 2,066,593 tons, and in 1878 the production was about 2,300,000 tons. With the steadiness in the currency which is now assured, and a continuance of the protective policy which has been in force since 1861, the production of pig-iron and of all kinds of iron and steel must continue to increase with the growth of the country in population and in general prosperity. The imports of iron and steel have fallen to merely nominal figures within the past few years, while our exports of these products and of articles manufactured from them is slowly increasing. The American consumers of iron and steel have never been supplied with these products at such low rates as are now charged—a result due wholly to home competition.

Iron production, 1852–'60.

1861.

Tariff of 1861.

Product of 1872.

1877–'78.

Imports and exports.

Distribution of the iron industry.

Distribution of the iron industry:

The manufacture of iron in the United States is now established in twenty-nine out of thirty-eight States, and in two Territories and the District of Columbia. The manufacture of steel is established in seventeen States. In each of the years 1877 and 1878 Pennsylvania made just one-half of the total production of pig-iron, and about 45 per cent. of all the rails produced. Her production of all kinds of rolled iron in these two years was about 40 per cent. of the total quantity rolled. In the manufacture of steel Pennsylvania has annually for several years produced more than one-half of the total product. Ohio is a large producer of

In 29 States.

Steel manufacture in 17 States.

Iron and steel products of Pennsylvania.

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UNITED STATES. pig-iron, her annual product being about 400,000 tons. New York is the next most important pig-iron producing State. In the manufacture of iron and steel rails Illinois is the second and Ohio the third State in the Union. The manufacture of crucible steel in the United States is mainly confined to Pittsburgh, in Pennsylvania, New Jersey being the next most important seat of this industry. Open-hearth steel is made in eight States, from New Hampshire to Tennessee. There are 11 establishments in the United States for the manufacture of Bessemer steel—1 in New York, 5 in Pennsylvania, 1 in Ohio, 3 in Illinois, and 1 in Missouri; all of these, except the last, were in operation in 1878. Michigan is the leading iron-ore producing State, the product in 1878 being 1,125,231 tons. Fully one-third of all the pig-iron produced in the United States is made from Michigan ores. New York, New Jersey, and Missouri have each yielded large quantities of iron ores for shipment to other States, as well as for use by local iron works. Virginia, Tennessee, Georgia, and Alabama have also furnished ores for shipment to other States. The iron ores of the United States embrace all the varieties that are needed in the manufacture of iron or steel, but it is proper to say that the manganiferous iron ores of the country, although existing in various localities, have not yet been fully developed, necessitating the importation of considerable quantities of spiegeleisen and ferro-manganese, for use in the Bessemer and open-hearth processes; also of Spanish and Mediterranean iron ores. Of coal there is an abundance, and, like the ores, it is well distributed. Neither of iron ores nor of coal will the United States ever be in want.

Iron product of: Ohio. New York.

Crucible steel.

Open-hearth steel.

Bessemer steel.

Ores of Michigan and other States.

General distribution of coal and ores.

Iron and steel statistics.

Iron and steel statistics.

Production in 1877 of iron and steel.

The production of iron and steel in the United States in 1877 was as follows, in English tons: Pig-iron, 2,066,593 tons; iron rails, 296,910 tons; Bessemer steel rails, 385,865 tons; all-rolled iron, not including rails, 1,021,624 tons; crucible steel, 36,098 tons; open-hearth steel, 22,349 tons; puddled and blister steel, 10,646 tons; Bessemer steel ingots, 500,524 tons. The production of Bessemer steel and of Bessemer steel rails greatly increased in 1878, the former amounting to 653,773 tons, and the latter to 491,427 tons. In 1867 the production of Bessemer steel rails was only 2,276 tons. The production of open-hearth steel increased in 1878 to 32,255 tons. Included in the rolled iron produced in 1877 were 4,828,918 kegs of cut nails and spikes, each keg of 100 pounds weight.

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UNITED STATES.

The number of blast-furnaces in the United States is now 700, of which not quite 300 were in blast in 1877 and 1878. These were generally the largest and best furnaces, the small and old-fashioned furnaces not being able to make iron at present prices. The number of rolling mills in the United States—separate establishments which have one or more trains of rolls—is 340, containing 4,463 single puddling-furnaces, double furnaces being counted as two single ones. The number of Bessemer steel works is 11, each having two converters, the capacity of all the converters varying from five to seven tons at each blow. The number of open-hearth steel works is 14, with a united annual capacity of about 90,000 tons. The number of crucible and other steel works is 46, with an annual capacity of about 100,000 tons. There are yet in operation in the country 64 Catalan forges, for the direct conversion of iron ore into wrought iron; these forges are mainly in New York and Tennessee, and in the former State they are wholly engaged in the production of iron for the manufacture of steel. Pig-iron is converted into blooms in 58 blomaries, which are mainly located in Pennsylvania.

Blast-furnaces.

Rolling mills.

Bessemer works.

Other steel works.

Catalan forges.

Blomaries.

Down to 1835 all the pig-iron manufactured in the United States was made with charcoal. In that year pig-iron was successfully made with coke at a charcoal furnace in Pennsylvania, and in 1836 coke was successfully used at another charcoal furnace in the same State. Other furnaces in Pennsylvania commenced to use coke soon afterwards. In 1837 a furnace was built in Alleghany County, Maryland, expressly to use coke, and in 1840 two other furnaces were built in the same county for the same purpose; all were successful in the use of the new fuel. In 1837 anthracite coal was successfully experimented with in charcoal furnaces in Pennsylvania in the manufacture of pig iron, and in 1838 a furnace was built at Mauch Chunk, in Pennsylvania, to use this fuel; this experiment was also successful. But the most satisfactory experiment with anthracite coal was made with the Pioneer Furnace at Pottsville in 1839, soon after which anthracite furnaces became quite numerous in Pennsylvania, New Jersey, and Maryland. Bituminous coal in its raw state was first used in a charcoal furnace in Mercer County, Pennsylvania, in 1845, and in 1846 it was successfully used in the Lowell furnace in Mahoning County, Ohio, which was built specially for the purpose. In 1877 there were produced with anthracite coal 834,640 tons of pig-iron; with bituminous coal, raw or coked, 948,165 tons; and with charcoal, 283,788 tons.

Charcoal used till 1835.

Use of coke commenced in 1836;

Of anthracite in 1837.

Pioneer Furnace, 1839.

Bituminous coal in 1845.

The Bessemer process for the manufacture of steel was

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UNITED STATES.

Introduction of Bessemer process in 1864. Siemens furnace in 1865.

introduced into the United States in 1864 and 1865, and the first steel rails were made in the latter year. In 1865 the first Siemens gas-furnace was built in the United States at Pittsburgh, to melt copper, and in 1867 the Siemens furnace was successfully applied to the manufacture of iron and steel at various places. The Siemens-Martin process was successfully introduced into the United States by Cooper, Hewitt, & Co., in 1868, at their works at Trenton, N. J.

Siemens-Martin process in 1868.

Coal statistics, 1875.

Complete statistics of the production of coal in the United States have not been compiled for a later year than 1875, when 47,513,235 tons were produced, of which 20,654,509 tons were anthracite, 26,031,726 tons were bituminous, and 827,000 tons were post-carboniferous. The production of bituminous coal is believed to have increased since 1875, but that of anthracite was less in 1878 than in 1875.

Imports of 1878; iron, spiegeleisen, steel rails, etc.

The imports into the United States in the fiscal year ended June 30, 1878, were 55,000 English tons, chiefly spiegeleisen, valued at $1,250,057; 30,359 tons of bar, sheet, plate, and other rolled iron, valued at $1,627,052; no iron rails; 10 tons of steel rails, valued at $530; machinery, valued at $628,667; steel ingots, bars, etc., valued at $1,220,037; cutlery, files, saws, and tools, valued at $1,295,764. To show the favorable change that has taken place in our imports of iron and steel, it may be stated that in the fiscal year 1872 there were imported into the United States 247,528 tons of pig-iron, valued at $5,122,318; 129,811 tons of bar, plate, sheet, band, hoop, and scroll iron, valued at $6,900,521; 421,755 tons of iron rails, valued at $15,778,941; 109,781 tons of steel rails, valued at $6,277,694; machinery, valued at $1,054,045; steel ingots, bars, etc., valued at $4,033,508; cutlery, files, saws, and tools, valued at $3,269,143. The exports of domestic products from the United States in the fiscal year 1878 included 5,781 tons of pig-iron, valued at $140,148; 10,090 tons of bar, sheet, plate, and railroad iron, valued at $482,908; 98 locomotives, 103 stationary engines, and other machinery and boilers, valued at $5,096,857; 70 tons of steel ingots, valued at $15,892; and cutlery, edge-tools, files, and saws, valued at $1,005,689. The imports of iron ore for the fiscal year 1878 aggregated 29,765 tons, valued at $62,787. In the fiscal year 1877 they were valued at $82,947, and the tonnage was estimated to have amounted to 41,473½ tons. In 1878 iron ore valued at $662 was exported. In the fiscal year 1878 there were imported 578,457 tons of coal, principally from Nova Scotia, Vancouver's Island, and Australia, and 660,138 tons were exported, of which 319,477 tons were anthracite and 340,661 tons were bituminous.

Comparison of imports of iron, steel, and their products in 1872; and exports of 1878.

Imports and exports of iron ore, and coal.

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COUNTRIES WHICH MAKE BUT LITTLE IRON AND STEEL.

Countries which make but little iron and steel.

The countries which unitedly make less than one and a half per cent. of the world's production of iron, and less than three-fourths of one per cent. of its production of steel, may be enumerated as follows:

Norway.	India.
Spain.	China.
Portugal.	Japan.
Italy.	Afghanistan.
Switzerland.	Persia.
Greece.	Australasia.
Turkey.	British America.
Algeria.	Mexico.
Morocco.	The states of South America.
Central and Southern Africa.	

Some of these countries, it is well known, will never produce much iron or steel, and the limited resources which they possess for their manufacture need not therefore receive much attention in this report; others, however, possess ample resources, and the extent to which they have been developed, or are likely to be developed, whether illustrated at Paris or not, may well receive consideration.

NORWAY.

NORWAY.

Beginning at the north of Europe is the first of the countries above mentioned. Its iron industry dates back several centuries, but it never reached a position of commanding importance, and it is now at a very low stage. In 1870 there were produced 21,155 Norwegian tons of iron ore; 3,975 tons of cast or pig iron; 845 tons of wrought iron; and 265 tons of steel. The Norwegian ton is equal to 2,200 English pounds. In 1861 the production was as follows: Iron ore, 24,385 tons; cast or pig iron, 7,575 tons; wrought iron, 3,895 tons; steel, 65 tons. The production of iron ore appears to have reached its maximum in 1865, when 49,720 tons were mined. The exports of iron ores, principally to England, increased from 335 tons in 1861 to 15,115 tons in 1870. Since 1870 the production and exportation of iron ores are said to have increased, but statistics are wanting. The exports of Norwegian iron amount to about 2,000 tons annually, and the imports to about 20,000 tons. The Baldwin Locomotive Works, of Philadelphia, have recently concluded a contract to supply four locomotives to Norway.

Production.

Exports of ores.

There are 42 rolling mills, nail factories, foundries, machine shops, etc., in Norway. Iron ore is not so abundant

Iron-mills and shops.

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NORWAY.

as in Sweden, and what there is is not well developed. The iron industry of Norway is not so productive as it was a hundred years ago. The causes of this decadence may be found in the climate, the scarcity of forests of timber suitable for the manufacture of charcoal, the great demand for timber for exportation, the entire absence of mineral fuel, and the poverty of the people. What little iron is made in Norway is excellent; it is all made with charcoal. Steel is made at only one establishment, the Naes Iron Works, where blister steel is first made by cementation and then melted in crucibles. It is not improbable that the iron and steel industries of Norway may some day take a fresh start, but they can never form an important factor in supplying the world's demands for these products.

Decadence of the iron industry.

Creditable exhibit in Paris.

Norway made at Paris a small but fitting display of her iron resources and of her progress in the manufacture of machinery and tools. The iron ores, and the iron itself, of Norway were illustrated by several fine samples. Jacob Aall & Son, of Naes, showed several specimens of iron ores, cast and bar iron, raw and crucible steel, several cast-steel cannon, and a collection of axes, hammers, files, and other tools. Plows, straw-cutters, and other agricultural implements, none possessing extraordinary qualities except strength, were exhibited; also several small engines. The Koaerner Works exhibited machine-made horse-shoes. Visitors to the Philadelphia Exhibition in 1876 will remember the unique and ingenious iron trophy, erected by the Catherineholm Iron Works, representing an ancient Norwegian ship, full-rigged and equipped, the whole composed of iron in appropriate forms. This ship was not exhibited at Paris.

Aall & Son.

Koaerner Works.

Catherineholm Iron Works.

SPAIN.

SPAIN.

Superior quality of ores.

Spain is very richly endowed with iron ores of the best quality, and she possesses coal with which she might smelt these ores; but Spain has almost wholly neglected her opportunities, and, instead of being an exporter of iron and steel, she is an importer of these articles and an exporter of iron ores, while her coal remains practically undeveloped. These results are the more suprising because anterior to the Christian era Spain was a manufacturer of iron. The sword blades of Toledo were celebrated during the Middle Ages. Catalan forges were so named hundreds of years ago from Catalonia, a province of Spain. But a change has recently taken place in public opinion in Spain in favor of the encouragement of domestic manufactures, the government giving special encouragement to the mining of coal by

Ancient celebrity.

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SPAIN.

requiring domestic coal to be used in the Spanish navy. The apathy and lack of capital of the Spanish people, and their need of a more extended railroad system, will, however, tend to retard the rapid multiplication of iron-works and coal mines in Spain.

Imperfect railway system.

The iron and steel exhibit made by Spain at Paris was surprisingly large and creditable. Four exhibits were especially noticeable—those of Duro y Compañia Langres la Felguera, in the Asturias; of Don Ybarra, of Barracaldo; of the Fabrica de Quiros; and of the Fabrica Nacional de Trubia. These exhibits embraced pig-iron and iron ores; bar, rod, sheet, plate, and shaped iron; iron rails; and puddled steel. Don Ybarra showed also samples of iron sponge made by the Chenot process. Jauragui, of Zorroza, showed some samples of wrought iron and cemented steel. The celebrated ores of Bilbao were well represented. Of the manufactures of iron and steel which were exhibited by Spain, mention may be made of a few good castings, of sabers and other cutlery and edge-tools, of portable and stationary engines, and of agricultural and other light machinery, the whole forming an interesting display. The principal iron-ore deposits of Spain lie on the northern coast, in the vicinity of Bilbao; but very promising mines have also been opened in the south of Spain, among which may be mentioned those of Palomares, in the Gulf of Vera, province of Almeria. Most of the Spanish ores are admirably adapted to the manufacture of Bessemer steel, and Great Britain, France, Belgium, Germany, and the United States are importers of them. The production of iron ores in Spain in 1877 was 1,162,170 metric tons, of which over 1,000,000 tons were exported to Great Britain, France, Germany, Belgium, and the United States.

Good exhibit.

Duro y Compañia Langres la Felgeura.

Don Ybarra.

Fabrica de Quiros.

Fabrica Nacional de Trubia.

Jauragui.

Ores of Bilboa.

Mines of Southern Spain.

Exports to the principal iron manufacturing counties.

Except Catalan forges, which are still in use in many provinces, the manufacture of iron and steel in Spain is confined to a few establishments, and these are chiefly in the northern part of the country. The works of La Felguera comprise 4 blast furnaces, 24 puddling furnaces, 10 reheating furnaces, 3 steam-hammers, 39 steam-engines, and a complete forge and rolling-mill plant. They have an annual capacity of 20,700 tons of pig-iron and 14,000 tons of rolled iron, including 5,000 tons of rails; puddled steel is made in small quantities. The works of Don Ybarra comprise 3 blast-furnaces and a well-appointed rolling-mill. There are a few other blast-furnaces and one or two small rolling-mills. The total production of iron in Spain in 1877 was about 100,000 metric tons, of which about 40,000 tons were wrought iron,

Catalan forges.

La Felguera.

Plant.

Production.

Don Ybarra.

Spanish iron production.

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SPAIN.

and 60,000 tons were pig-iron. Pig-iron is made in part with charcoal and in part with coke. The Duro Company, of La Felguera, has Belgian coke-ovens at Vega, and employs machinery for washing the coal. The production of steel in Spain was only 216 metric tons in 1873. The first blast-furnaces in Spain are said to have been erected near Marbella, on the Mediterranean, in 1828.

Imports of iron and steel.

The imports of iron and steel into Spain in 1875 were as follows: Pig and scrap iron, 19,008 metric tons; rails, 11,360 tons; plates, sheets, etc., 5,904 tons; hardware of iron and steel, 5,483 tons. In 1874 there were imported 40,251 tons of bars, hoops, etc., and 3,222 tons of steel. In 1877 Great Britain exported to Spain 33,237 English tons of iron and steel. Of Spanish iron and steel exports statistics are wholly wanting, and probably there are no such shipments to be recorded.

Coal production.

The production of coal in Spain in 1876 was 706,814 metric tons, and the imports, chiefly from Great Britain, were 774,770 tons. The coal of Spain has been almost wholly developed since 1830, when 10,524 tons were mined. The principal development has been in the northern part of the country. No exports are recorded. The number of miles of railroad in Spain is about 4,000.

PORTUGAL.

PORTUGAL.

Portugal possesses both coal and iron ore in considerable quantities, and companies have recently been formed for their development. Two blocks of iron ore, showing very excellent analyses, were exhibited at Paris by the owners

San Thiago mines.

of the iron mines at San Thiago. This company was established by English and French capitalists in 1877, with a capital of $140,000, and its mines are advantageously situated in the province of Alemtejo. Small quantities of iron are made by a few forges in the mountains of Portugal.

Coal.

The production of coal in Portugal is said to have amounted to 12,387 metric tons in 1872, since which year there are no statistics. In 1876 the exports of iron ore amounted to 21,568 tons. At Paris there were several pieces of machinery and specimens of cutlery exhibited by Portugal, which showed mechanical skill of a higher order.

ITALY.

ITALY.

Italy is a country of considerable manufacturing enterprise.

Want of coal.

Unfortunately there is scarcely any coal in her territory, and this want has prevented the complete development of her iron industry. She has an abundance of iron ores, and on the

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ITALY.

island of Elba they are of unsurpassed richness. The iron ores on this island and in other parts of Italy were used long before the Christian era. There are three principal iron districts in Italy additional to Elba—Lombardy, Piedmont, and Tuscany. In all Italy there are about 40 blast furnaces, many of which, owing to the scarcity of fuel, have not recently been in operation. Catalan forges for smelting iron ore and bloomaries for refining pig-iron are largely used in Italy, their number being about 200. Charcoal is the principal fuel used in the furnaces, forges, and bloomaries, the Appenine forests furnishing the most of it. There are four furnaces in Italy that were built to use British coke. In 1862 works for the manufacture of cemented steel were established at Naples, and since that date Siemens furnaces have been introduced at works in Lombardy and elsewhere for puddling iron and steel and for melting steel in crucibles. There are no large rolling-mills in the kingdom. Owing to the scarcity of fuel, most of the ore mined in Italy is exported, the quantity annually sent out of the country exceeding 200,000 tons. The annual production of pig-iron ranges from 20,000 to 25,000 tons, and that of wrought iron is about 50,000 tons. The production of steel in 1876 was 2,800 tons. In the same year the imports of iron and steel into Italy were as follows: Pig-iron, 22,535 metric tons; castings, 5,352 tons; rolled iron, 93,713 tons; iron and steel rails, 40,227 tons; steel, 4,853 tons. The exports of iron and steel are only nominal. The quantity of coal imported in 1876 was 1,454,542 tons, of which Great Britain furnished much the larger part. It will be observed that Italy is a large purchaser of iron, steel, and coal. Steel rails are coming into general use on Italian railroads, the length of which is about 5,000 miles. Throughout the country are many foundries and machine-shops, cutlery works, etc., and in Naples is an establishment which has produced in the last fourteen years 142 locomotives, 72 boilers for old engines, 463 passenger cars, 2,190 freight cars, and several bridges and via ducts, foreign iron and steel being generally used.

Ores of Elba.

Furnaces, forges, and fuel.

Steel-works.

Export of ore.

Production of iron and steel.

Imports of iron and steel.

Exports of iron and steel.

Railways.

Railway shops.

Italy made a creditable but not extensive display at Paris of machinery, edge-tools, files, railway material, iron ores, etc., but none of her exhibits call for special notice. As a manufacturer of hardware, cutlery, tools, castings, steam-engines, locomotives, and similar products Italy is rapidly attaining a respectable rank, but no probability exists that she will within any reasonable limit of time make all the iron and steel her people need.

Exhibit.

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SWITZERLAND.

SWITZERLAND.

Switzerland is not noted as a manufacturer of iron or steel. The country contains three charcoal furnaces and one coke furnace, which make annually about 3,500 tons of castings and 4,000 tons of forge pig-iron. The latter is converted in charcoal forges into wrought iron. There are also a few small rolling-mills, which are supplied with pig-iron from other countries. Iron ore is abundant in Switzerland, but coal is scarce. The Swiss have given much attention to the manufacture of cutlery, tools, and machinery, and at Paris their display of these articles was the subject of much favorable comment. Several fine steam-engines were exhibited, and some small hydraulic engines. Several firms exhibited files of superior workmanship made of imported steel, and there was also a small but handsome collection of pocket-knives and fine cutlery. Of machines and machine castings there was a good display, and this also may be said of locomotives and all railway appliances. Of the latter there were seven exhibitors, including the Aarau Works, which exhibited a locomotive weighing twenty tons, intended for heavy grades.

Abundance of ore.

Scarcity of coal.

Engines, machines, and tools.

Aarau Works.

Imports of iron, steel, and products.

In 1877 Switzerland imported 20,279 metric tons of pig-iron and raw steel; 14,504 tons of bar-iron; 11,487 tons of iron and steel rails and railway sleepers; 8,113 tons of plates; and 22,000 tons of miscellaneous iron and steel products. Her exports of these commodities are inconsiderable. The annual imports of coal average about half a million tons. Switzerland has about 1,400 miles of railroad.

GREECE.

GREECE.

Greece contains very rich iron ores on the island of Seriphos, some of which have been exported, but it contains no iron works that are now in use, except perhaps a few forges. About 1870 an attempt to smelt these ores with native lignite resulted in failure. A collection of Greek ores was exhibited at Paris and some specimens of Greek machinery. Coal and lignite are mined in small quantities in Greece. There is no immediate probability of any increase in the production of either iron or coal. The country consumes but little iron.

TURKEY.

TURKEY.

Turkey produces in charcoal furnaces and by primitive methods in Bosnia and Servia, and in the Lebanon Mountains and elsewhere in her European and Asiatic territory, about 40,000 or 50,000 tons of iron annually. The fuel used

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is wholly charcoal, and the iron ores are of good quality. Coal is mined on the southern shore of the Black Sea, and the annual product is about 150,000 tons. Coal and lignite have been discovered in other parts of the empire, but, like everything else of a desirable nature in that country, they await development. The production of iron need not be expected to increase until more coal is mined and more railroads are built, as the supply of timber for charcoal is rapidly being exhausted in the neighborhood of existing iron-works. Iron ore is abundant. Some of the Turkish iron is equal to the best Swedish. In 1877 Turkey imported 217,643 metric tons of coal, and imported from Great Britian 7,403 tons of iron and steel. Turkey in Europe contains about 1,000 miles of railroad, Turkey in Asia about 250 miles, and Roumania about 800 miles.

TURKEY.

Coal and lignite.

Deficient transportation.

Abundant ore.

Good iron.

Imports.

Railways.

ALGERIA.

ALGERIA.

Algeria is noted for its rich iron-ore deposits, which have been worked by French capitalists for about thirty years. The principal mines are those of Mokta-el-Hadid, near the port of Bona, and their product in 1877 was 370,810 tons. The company which owns the Mokta mines also produced in the same year 121,852 tons of coal, the greater part of which was exported. The Beni Saif iron-ore mines, worked by the Soumah Company, are the next most important in Algeria, of which there are fourteen in all. From all the iron-ore mines of Algeria there were exported 466,026 tons in 1875 and 455,314 tons in 1876. The exportation of Algerian ore is not increasing, although there is no apparent limit to the supply if underground workings be resorted to. Pig-iron is made at one furnace near Bona, with native coal and coke.

Rich ore deposits.

Products in ore and coal.

MOROCCO.

MOROCCO.

Good iron ore is found, but it is undeveloped.

AFRICA.

AFRICA.

In Central Africa the natives have long made warlike and other implements of iron by simple but very effective processes. Hammers and chisels, swords, daggers, spear-heads, and arrow-heads are made of a quality deserving the highest praise. Their chains are said to be equal to the best English steel chains.

Central Africa.

Fine quality of iron made by native processes.

Southern Africa possesses in the Transvaal extensive deposits of iron ore and coal, samples of which were exhibited at Paris. Some progress has been made in mining coal, but

Ore and coal of the Transvaal.

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AFRICA.

none in mining ore. Coal has also been found in Cape Colony, in the Orange Free State, and in Natal. Madagascar is said to contain both iron ore and coal.

Coal and ore.

All the territorial divisions of Western Africa are said to be rich in iron ores.

INDIA.

INDIA.

Primitive iron and steel processes.

India has made iron and steel by primitive methods from the earliest ages. Iron ore is found in various localities, and so also is coal. The government of the country, aided by British capitalists, is doing much to develop both of these sources of wealth, several companies having been organized to mine coal and manufacture iron. Many of these enterprises are now in operation, and all of them are said to promise successful results, but for many years to come India must remain a large importer of both coal and iron. In 1877 Great Britain sent 229,421 tons of iron and steel and 894,174 tons of coal to British India. The country produces about 500,000 tons of coal annually, and has 7,599 miles of railroad.

Development.

Imports of iron, steel, and coal.

Railways.

CHINA.

CHINA.

Abundance of good ore and coal, well distributed.

China has an abundance of good iron ores and equally good coal, both anthracite and bituminous, all well distributed. The iron ores have been but slightly developed, only the most primitive methods for smelting and refining them being in use, blast furnaces having scarcely an existence. Coal is mined on a scale somewhat extensive for a country that has made such little use of modern mining appliances. It is estimated that the annual production of coal in China is about 3,000,000 metric tons, of which 1,000,000 tons are anthracite. The quantity of iron annually produced cannot even be estimated, but it almost equals the wants of the country, as China imports but little iron or steel. At Paris there were exhibited by China some very fine samples of wrought iron, made from magnetic iron sand, and apparently equal to Swedish iron. A collection of plows, sickles, shears, and other tools and implements showed that the Chinese are not very expert in the manipulation of iron. Some samples of coal were exhibited. Apparently but little progress in the development of either their iron or coal resources may be expected from a people who have just destroyed the only railroad within the boundaries of their extensive empire. If the locomotive could be introduced into every Chinese province the manufacture of iron would soon become an important Chinese industry, and the mining of coal would be greatly increased. In 1875 China imported from Great Brit-

Output of coal.

Exhibits of good iron.

Iron implements and tools.

Deficiency of transportation.

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ain 59,332 metric tons of coal and 1,529 tons of coke. Statistics of the imports of iron and steel are wanting.

CHINA.

Imports of coal.

JAPAN.

JAPAN.

Japan, as is well known, is a progressive country, and is rapidly adopting all the arts of modern civilization. There are at present 66 miles of completed railroad in Japan and 142 miles in course of construction, with several hundred additional miles projected. These railway statistics possess of themselves great significance, but to this must be added the recent erection of several modern blast furnaces and a rolling-mill, under the direction of English engineers. In some of the furnaces charcoal is to be used, and in others coke. The Japanese, however, still make use of primitive processes for the manufacture of iron and steel, but this is not so much the result of conservatism or prejudice as of necessity. The ore used in these processes is largely magnetic iron sand. Other ores are to be used in the new furnaces. The annual production of iron in Japan is about 10,000 tons. Coal is mined in a primitive fashion on the Island of Yesso and on other islands in the empire, the annual production being about 400,000 tons; it is mostly bituminous, but some anthracite and lignite are found. It may reasonably be presumed that the production of coal in Japan will increase in future years, as the people are disposed to adopt modern methods for its extraction. A block of bituminous coal from Japan was exhibited at Paris, as were also samples of Japanese iron ores and cutlery. In the manufacture of tools from native iron and steel Japanese mechanics are known to be both skillful and tasteful.

Railways finished and projected.

Modern iron furnaces.

Primitive processes.

Product in iron.

Coal.

Cutlery and tools.

CENTRAL ASIA.

CENTRAL ASIA.

In Afghanistan and Persia there are small quantities of iron made by the most primitive of processes.

AUSTRALASIA.

AUSTRALASIA.

The grand division of the earth's surface known as Australasia, which includes Australia, New Zealand, Van Dieman's Land, etc., has thus far produced but little iron, but in the mining of coal much progress has been made in New South Wales, which produced 1,444,271 metric tons in 1877, of which 915,727 tons were exported. Coal mining in this colony dates from 1829. In the other colonies of Australasia very little coal is mined. Iron ore is found in New South Wales in large quantities, and furnaces and rolling-

Output of coal in New South Wales.

Ore in New South Wales.

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AUSTRALASIA.

Victoria.

Tasmania.

New Zealand.

South Australia.

Imports.

Railways.

mills have been erected. In the colony of Victoria there are a number of large foundries, machine shops, and rolling-mills. In Tasmania a furnace was erected in 1875, and in New Zealand a furnace has also been erected. In South Australia there is another furnace. It is understood, however, that several of these enterprises have been unsuccessful. In 1877 Great Britain exported to her Australian colonies 215,905 English tons of iron and steel. Specimens of the iron ores and coal of this part of the British Empire were exhibited at Paris, including chrome ores. In the manufacture of agricultural implements, engines and boilers, and similar products, Victoria and some other colonies have made great progress. There are about 2,700 miles of railroad in Australasia.

BRITISH AMERICA.

BRITISH AMERICA.

Coals of.

Nova Scotia.

Vancouver's Island.

Exports.

Imports.

Steel Company of Canada.

British America contains coal at its eastern extremity in Nova Scotia, and at its western extremity in Vancouver's Island, but very little coal has been developed in the intervening territory. For the manufacture of iron, however, this country could either use charcoal, of which there is abundance of timber to furnish a supply, or coal could easily be obtained from the United States. The total production of coal by the mines of Nova Scotia in 1877 was 757,496 English tons, and the production of the mines of Vancouver's Island in the same year was 154,052 tons. The exports of coal from Nova Scotia to points outside of British America amounted to 136,828 tons in 1877, principally to the United States; the exports from Vancouver's Island in the same year amounted to 139,692 tons, principally to the same country. The imports of coal into the Dominion of Canada in the fiscal year ended June 30, 1877, amounted to 979,692 tons, of which the United States furnished 789,697 tons, Great Britain 189,965 tons, and the island of St. Pierre 30 tons. Iron ore of variable quality is found at various places in the Dominion, but few of the efforts that have been made to develop it have met with success, the most successful enterprise being the works of the Steel Company of Canada, which are located at Londonderry, in Nova Scotia, and consist of 3 blast furnaces, 1 rolling-mill, machine shops, 2 foundries, and an open-hearth steel plant. The company owns extensive ore and coal mines, and has a capital of $2,500,000. Its affairs are very ably managed, and every part of the works is constructed and operated upon the most approved modern principles. The whole establishment is very complete and is in constant operation,

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manufacturing pig-iron, bar-iron, car wheels, steel, etc., but it is the only complete iron-making establishment in the Dominion. The movement that has been inaugurated to give to Canada a protective tariff will do much for the iron industry of that country, and it need scarcely be added that in the prosperity of the iron and other industries of Canada this country will rejoice. BRITISH AMERICA. Prospective protective tariff in Canada.

The Dominion of Canada is reported to have made about 11,000 tons of pig-iron in 1877. In the same year it exported to the United States 7,755 tons of iron ore. No other statistics of production are attainable. Great Britain enjoys the lion's share of the British American import trade. In 1877 the mother country sent to British America 119,504 tons of iron and steel, which was a much less quantity than 172,079 tons, which were sent in 1875. The United States exported to the Dominion of Canada, according to a statement kindly supplied by Hon. J. Johnson, the Canadian Commissioner of Customs, iron and steel and manufactures of iron and steel to the value of $5,194,909 in the fiscal year ended June 30, 1876; $4,423,336 in the fiscal year ended June 30, 1877; and $4,039,579 in the fiscal year ended June 30, 1878. The Canadian iron and steel exhibits at Paris were neither extensive nor specially noticeable. Canada has about 5,000 miles of railroad. Production of pig-iron. Export of ore. Canadian imports of iron, steel, and manufactures. Railways.

MEXICO.

MEXICO.

Mexico has iron ore in abundance, and some of her deposits are of remarkable extent and richness, but her people are not enterprising as manufacturers, nor do they have coal to stimulate them to engage in the manufacture of iron. There are less than a dozen blast furnaces and rolling mills in the country, which produce annually about 7,500 tons of iron. Mexico has about 600 miles of railroad. This country will probably not greatly increase its production of iron for many years to come. Production of iron. Railways.

In 1874, the latest year for which complete statistics are at hand, Mexico imported all its coal from the United States, 5,660 tons; 5,474 tons of "wrought and unwrought iron and steel" from Great Britain, and none from other countries; steam-engines, machinery, and other iron manufactures, to the value of $988,675, from the United States; and machinery, hardware, and cutlery, to the value of $799,345, from Great Britain. Import of coal, iron, and iron manufactures.

SOUTH AMERICA.

SOUTH AMERICA.

South America is not wanting in either iron ore or coal. The United States of Colombia have long had two small char-

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SOUTH AMERICA.

coal furnaces and a small rolling-mill. Another furnace is projected. Coal is found near the city of Bogota and elsewhere.

Chili coal.

Chili produces annually about 300,000 tons of coal, but iron is not made except in very small quantities. The competition of British coal greatly interferes with the prosperity of the Chilian coal mines. In the past five years Chili has imported coal of the value of $4,000,000, of which Great Britain supplied 98 per cent.

Imports of British coal.

Peru.

Peru has both coal and iron ore.

Ecuador.

Ecuador has iron ore.

Bolivia.

Bolivia has both iron ore and coal.

Argentine Republic.

So has the Argentine Republic—all practically undeveloped.

Brazil.

Brazil has iron ore and coal, and the government of the country encourages their development, but thus far but little has been effected in this direction. Several coal mines have been opened, and in the province of Minas Geraes some iron has been made in primitive forges.

Ore and coal.

Imports of coal, iron, and steel into Brazil, Chili, Peru.

Brazil imported in 1877 from Great Britain 340,083 tons of coal and 59,164 tons of iron and steel. Chili imported 14,218 tons of iron and steel from Great Britain in 1875, and only 1,011 tons in 1877. Peru imported 16,218 tons of iron and steel from Great Britain in 1875, and only 2,720 tons in 1877. With the exception of Brazil, no South American country consumes much iron and steel. In all South America there are about 6,000 miles of railroad.

Exports of the United States to Mexico, West Indies, Central America, South America.

In the fiscal year ended June 30, 1877, the United States exported to Mexico miscellaneous manufactures of iron and steel, and 438 tons of pig and rolled iron and steel, all valued at $649,588, and 1,304 tons of coal, valued at $7,746; to the West Indies and Central America, miscellaneous manufactures of iron and steel, and 3,582 tons of pig and rolled iron and steel, all valued at $1,419,893, and 80,372 tons of coal, valued at $292,979; to South America, miscellaneous manufactures of iron and steel, and 1,447 tons of pig and rolled iron and steel, all valued at $2,470,289, and 14,367 tons of coal, valued at $51,838.

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SPECIAL FEATURES OF THE PARIS EXPOSITION.

Special features of the Exposition.

In making a general survey of the features of the Paris Exposition which relate to iron and steel, I am led to the conclusion that they presented but little that was new to the practical man who is engaged in the manufacture of these products. There were representations of progress in the dephosphorization of iron, in the substitution of machine for hand puddling, in the simplification and perfection of the open-hearth process, in the casting of steel, in the manufacture of wrought iron and steel directly from the ore, and in the application of both iron and steel to new uses; but no absolutely new process for the manufacture of iron or steel was exhibited or described, nor were its products represented. The metallurgical world has appareutly reached a resting place in the invention of new processes in the manufacture of iron and steel, and iron and steel makers everywhere appear to have reached the conclusion that in the improvement of present processes and in an extension of the use of iron and steel are they to find problems worthy of their attention in the future.

Examples of progress in iron and steel processes.

Application of iron and steel to new uses.

No distinctively new processes.

Of the whole display of iron and steel products at Paris, and of machinery applied to the manufacture of iron and steel or to other manufacturing purposes, I cannot speak in terms of sufficient praise. The display of iron and steel products has never been equaled at a world's fair, while the display of machinery generally has only been equaled by that made at Philadelphia. The Philadelphia exhibit of machinery was more extensive and more varied than that of Paris, and it possessed an additional advantage in being more generally in motion. But the Paris Exposition demonstrated more fully than the Philadelphia Exhibition, or any previous international exhibition, the efficiency of machinery in all industrial enterprises, the efforts of every progressive nation to obtain the best machinery for its own service, and the necessity imposed upon all, by their active competition with one another, to adopt every new device and improvement which tends to increase, perfect, and cheapen products. Referring particularly to the iron and steel exhibits, and to the explanatory and supplementary information which I have presented concerning them, it is clearly demonstrated that modern processes and modern machinery for the manufacture of these products are now in general use in all leading iron and steel making countries, and that the skill nec-

Whole display admirable.

Comparison of the machinery exhibits at Philadelphia, 1876, and Paris, 1878.

Modern processes and machinery in use in all leading iron and steel-making countries.

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Special features of the Exposition.

No nations have monopoly in any kind of iron or steel, process or machinery.

essary to apply them is rapidly being equalized. No nation now has a monopoly of the manufacture of any kind of iron or any kind of steel, or of the use of any machinery necessary to their production. Some countries will, of course, continue to display greater enterprise than others in the utilization of their resources for the manufacture of iron and steel, but none of the leading nations of the world will lag behind because they have not become practically familiar with the best methods adapted to this utilization.

Closely allied to this subject is another fact with which the observant visitor at Paris could not fail to be impressed, and which has been prominently illustrated in this report—

General distribution of iron ore and coal

the general distribution of good iron ores in all countries, and the equally general distribution of mineral fuel to smelt them. Countries that were once supposed to contain but little good iron ore are found to possess large and practically inexhaustible deposits of the best of ores, and countries that were not known to possess coal deposits of any magnitude or of good quality are found to possess almost boundless

Sweden and Italy: rich in ore, poor in coal.

carboniferous resources. Sweden and Italy are the only two of the leading countries of the world that are at once rich in iron ores and poor in mineral fuel. Russia, Austria, and Germany have more and better coal than has been generally conceded to them. If Spain, Portugal, Turkey, India,

Abundance of coal in countries cited.

China, Japan, and Australia shall ever attempt the manufacture of iron in large quantities, their progress will not be impeded because of a deficiency of domestic coal. Even in countries where native coal is not of the best quality for

Processes for neutralizing bad effects of poor coal.

smelting iron ores or refining iron, the methods now generally in use for removing impurities or for making iron and steel with gas will be found to neutralize very largely this inferiority.

A fact of much significance connected with the natural distribution of iron ores was perhaps more fully illustrated at Paris than at any previous international exhibition. Owing to the marvelous increase in the production of Bes-

Manganiferous and non-phosphoriferous ore of Spain, Algeria, and Italy needful for Bessemer practice.

semer steel in late years, the manganiferous and non-phosphoriferous ores of Spain, Algeria, and Italy have been largely drawn upon for supplies to Bessemer works in countries rich in other varieties of ores. These Bessemer ores were liberally exhibited at Paris, and they served to mark and to emphasize the great dependence of the Bessemer steel industries of Great Britain, France, Germany, and Belgium upon foreign sources of ore supply, and the virtual equalization of the cost of Bessemer ores to all these countries.

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Special features of the Exposition.

But a fact of still greater general significance was illustrated at Paris in the large and varied collection of Bessemer products which was there exhibited. All the leading iron-making countries exhibited Bessemer steel, and in almost every form in which other kinds of steel and all kinds of iron have heretofore been used. The revolution which the Bessemer process has wrought in the iron trade was made strikingly manifest in a survey of the contributions of European countries, but to an American who remembered the wonderful development of the Bessemer industry in his own country, which sent no Bessemer products to Paris, these contributions were more impressive and more suggestive than they could be to any European. It is a trite saying that the age of steel has come, and that the manufacture of iron is giving place to that of steel, but the Paris Exposition showed that the progress made during the past two or three years in the manufacture of Bessemer steel, and open-hearth steel as well, is so great, that statistics fail to give any proper conception of its magnitude. The London "Times" remarks that "the Bessemer process has ruined the manufactured-iron trade;" but it has done more than this—it has distributed among many countries the manufacture of Bessemer steel, and thus enabled them to supply more fully their own metallurgical wants and the metallurgical wants of other countries, in lieu of their own previous partial dependence upon Great Britain for both iron and steel products. It has thus aided not only to ruin the manufactured-iron trade of all countries, but to ruin that of Great Britain particularly, and it has placed a limit upon the Bessemer steel industry of Great Britain itself. Here is a new revolution, or a new revelation, in connection with the world's iron industry which was reserved for Paris to make clearly manifest through the abundant proofs there furnished of the wide distribution of the Bessemer process and the wide substitution of Bessemer products for those of iron and other steel processes. And what has been said of the Bessemer process and of the injury it has inflicted upon the British iron trade is applicable also in a large degree to the Siemens-Martin process and its modifications.

Bessemer steel has wrought a revolution in the iron trade.

The present "age of steel."

Open-hearth steel.

The Bessemer process the ruin of the manufactured-iron trade.

Is enabling other countries to become independent of Great Britain.

Wide distribution of the Bessemer process, and substitution of its products for iron.

Siemens-Martin process.

With one exception, the Paris Exposition did not furnish any valuable suggestions of new uses for iron. This exception relates to the introduction of various systems of iron permanent way for railroads, in place of the wooden cross-ties and stringers which are now generally in use. One of these systems, Hilf's, has been adopted on nearly a thousand miles of railway in Germany, Austria, Belgium, and other

Iron permanent way.

Hilf's system.

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Special features of the Exposition.

countries. Both the stringers and the cross-ties are of wrought iron. Other systems, at least one of which substitutes steel for iron, are modifications of the Hilf system. It seems not improbable that one or two of these systems will become popular and even necessary in countries which do not possess an abundance of timber, but at present many objections are made to their adoption. It is alleged that the first cost of an iron permanent way, cheap as iron has become, is much greater than one of wood, and that it is liable to corrode, and is more rigid than wood. I did not notice at Paris nor in my travels that much progress had been made in the substitution of iron for wood in the construction of railway cars. Concerning some other uses to which iron has been adapted within a comparatively recent period, I learned that iron is every year coming into more general use in Europe as a substitute for wood in the construction of buildings and parts of buildings, in the construction of bridges, in telegraph poles, in mining operations, and in fencing. I would not discourage the hope that the use of iron for all of the purposes which have been mentioned will increase from year to year, but this increase must be gradual in all countries, and in our own country the general introduction of an iron permanent way must be long delayed.

Iron permanent way as a substitute where fuel is scarce.

Iron railway cars.

Iron buildings, bridges, fences, etc.

Compressed mineral fuel.

A product of economic interest and of rapidly increasing economic value was represented at Paris in numerous exhibits of compressed mineral fuel, or briquets, composed chiefly of inferior coal or coal waste, to which is added coal-tar as a cement. France, Belgium, Germany, and even Great Britain manufacture this new fuel, France obtaining part of her supply of the raw material from Wales, and finding a market for the sale of a portion of the manufactured product in Italy, where it is used as fuel for locomotives. Machines for the manufacture of this fuel were also exhibited at Paris, much space being occupied by them in the French section. As has already been remarked, France annually produces about 700,000 tons of briquets and Belgium about 500,000 tons; Germany and Great Britain, respectively, manufacture smaller quantities. Its increased production in Europe is assured. At present it is mainly used upon steamships and in locomotives. In this country a successful attempt to manufacture compressed fuel from anthracite coal dust has been made on a large scale at Fort Ewen, near Rondout, N. Y., and to-day the enterprise is firmly established, the fuel, which is in large lumps, being supplied to steamships and locomotives. Mr. E. F. Loiseau, an Ameri-

Briquets for locomotives.

Production of *briquets*.

American practice.

Loiseau's process.

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Special features of the Exposition.

can gentleman, has recently perfected machinery for the economical manufacture of the same kind of fuel in smaller lumps, for general use. The possibilities of the compressed-fuel manufacture are large and important, and do not lie wholly outside of the manufacture of iron and steel, but in this country the abundance and cheapness of good coal will long operate as an impediment to the utilization of the dust which has accumulated or may accumulate in the vicinity of our coal mines. It may be added that General Manager J. E. Wootten, of the Philadelphia and Reading Railroad Company, has invented a grate for locomotive and stationary engines by which anthracite coal dust can be successfully and economically used as fuel. Several of these grates are in use by the company. The only American locomotive exhibited at Paris was built and sent by this company and was furnished with one of these grates, by which it can be operated with either coal dust or lump coal, without any change in the grate or fire-box. It was successfuly tested on several French railroads, and has since been taken to Switzerland, where it has given great satisfaction in the use of the fuel of that country. From Switzerland it is to be taken to Italy.

Compressed fuel.

Wootten's grate for burning coal dust.

Shown on the Philadelphia and Reading locomotive in Paris.

Used in France and Italy.

During my stay in Paris it was my good fortune to be present at a meeting in that city of the Iron and Steel Institute of Great Britain. This body is composed of several hundred of the leading metallurgists of the world, a majority being iron and steel manufacturers of England, Scotland, and Wales. At its meetings, which are held at least twice a year, are discussed scientific questions of the greatest importance to all iron and steel manufacturers, and to these discussions may be justly attributed much of the progress that has been made in the manufacture of iron and steel in all countries since the establishment of the Institute in 1869. Such men as Bessemer, Samuelson, the Duke of Devonshire, Bell, Whitwell, Snelus, Mushet, Siemens, Menelaus, Adamson, Akerman, Tunner, Wedding, Gruner, Jordan, Schneider, Fritz, and Holley have placed iron and steel manufacturers everywhere under heavy obligations to them for freely giving to the world the results of their patient studies and laborious experiments in connection with the work of blast furnaces, rolling mills, and steel works. At the Paris meeting there was an unusually large attendance of the members of the Institute, and the papers read were of an instructive and valuable character. I earnestly commend to my countrymen who are engaged in the manufacture of iron and steel the example of the Iron and Steel In-

Iron and Steel Institute of Great Britain.

Discussions.

Leading minds in the progress of the steel industry.

Meeting of the members of the institute in Paris.

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Special features of the Exposition.

stitute of Great Britain. All proper agencies which now exist for the acquisition and dissemination of information necessary to the continued scientific development of our iron and steel industries should be strengthened and perfected. In these industries, at home as well as abroad, science rules the day and the hour; old methods have passed or are rapidly passing away, and the utmost economy, skill, and technical knowledge are essential to success. Much as we have already learned—much as we have ourselves invented—I assure American manufacturers of iron and steel that we can yet learn from our fellow-craftsmen in other countries, and that we *must* learn from them if we would equal all of their best achievements.

Our need of agencies for the dissemination of information.

Causes of the general business depression.

CAUSES OF THE UNIVERSAL BUSINESS DEPRESSION.

Leaving the Paris Exposition, I now turn to a consideration of the present condition of the European iron and steel industries. First, however, it is proper that some notice should be taken of the present industrial condition of all countries which are largely devoted to manufactures.

That the manufacturing industries of leading European countries, as well as of the United States, have been depressed for many years is news to no reader of this report. This depression has had various causes, some immediate and others remote, and it has not had its beginning at the same time in all countries; but, whatever its causes, and whether early or late its beginning, it has reached all manufacturing countries, and through its influence upon them it has affected the prosperity of the whole world. Europe, being more exclusively devoted to manufactures than the United States, and having a dense population, has suffered the most from this depression; the United States, being mainly an agricultural country, with a population widely distributed, and with manufactures which have been built up for the supply of the home market rather than the foreign market, and have been protected at home from unlimited foreign competition, has suffered the least, and is the first country to begin to recover from its effects.

Europe has suffered more relatively than the United States.

Reasons.

Query: as to the causes of the universal depression.

The inquiry is naturally suggested whether the universal depression has been created by the numerous wars of the past few years, particularly by the civil war in the United States from 1861 to 1865, the war between Prussia and Austria in 1866, the war between Germany and France in 1870 and 1871, and the war between Russia and Turkey in 1877 and 1878. Undoubtedly these wars influenced unfa-

Extensive wars.

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vorably the manufacturing industries of many countries, by first partially arresting their healthy activity and afterwards unduly stimulating their development. In the United States, Austria, and Germany this forcing of manufacturing activity was accomplished largely through the influence of an increase in the currency, itself a result of war; but neither the recent wars, nor the inflation of the currency which accompanied some of them, will sufficiently account for the depression and distress with which the civilized world is today so familiar.

Causes of the general business depression.

First among additional causes may unquestionably be placed the influence of machinery in cheapening and increasing manufactured products. By means of the mechanical inventions of the past twenty years, manufacturing nations have attained a productive capacity in excess of the consumptive capacity of both civilized and half-civilized nations. This is true of manufactures of cotton, silk, and woolen goods; and it is especially true of manufactures of iron and steel, in which must be included all railway appliances. This development of manufacturing facilities would have taken place if there had been no wars, for the invention of the steam-engine, of railroads, and of the magnetic telegraph, and the discovery of gold in California and Australia, gave such an impetus to the world's progress that improvements in labor-saving machinery, for the supply of new wants and to meet new conditions of civilization, were certain to follow.

Influence of machinery in cheapening and increasing manufactured products.

Next among the causes of world-wide depression must be placed the slackening of the demand for new railroads. For a period of about ten years prior to 1873 all of the leading countries of the world and many of the second and third rate countries were actively engaged in building railroads, to afford means of communication between the several parts of their territories or to develop their latent resources. Many countries which were rich in enterprise but poor in ready money were assisted by the money-lenders of other countries to build these roads. While this work was in progress many branches of manufactures and of mechanical and engineering construction were liberally drawn upon for materials and labor, and to meet this demand the erection and equipment of new iron and steel works, locomotive works, car works, and minor industrial establishments were rendered necessary. In 1873 and immediately succeeding years it was found that as many of these railroads had been constructed as were required by the necessities of the countries building them, or as they were

Slackening of the demand for new railways.

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Causes of the general business depression.

able to pay for, or could borrow money to pay for, and with the total or partial cessation of the demand for new railroads a check was at once given to all the industries which had been built up or enlarged in expectation of a continuance of this demand. Millions of capital were found to have been unprofitably invested; armies of skilled and unskilled workingmen were thrown out of employment; and small industries, dependent upon the prosperity of the greater industries which had been abnormally stimulated, either perished outright or were able to maintain only a sickly existence.

Check to railway enterprise.

Railway statistics.

The railway statistics of Great Britain, Germany, and the United States are sufficiently illustrative of the stimulating influence upon the iron trade and related industries of the fever for building new railroads that has existed in late years, and of the depressing effect of the subsidence of this fever. From 1855 to 1873 the railway mileage of Great Britain increased from 8,335 miles to 16,082 miles, or almost doubled. At the beginning of 1878 the mileage had increased to only 17,109 miles. The railway mileage of Germany increased from 4,863 miles in 1855 to 8,637 miles in 1865; to 17,372 miles in 1876; and to 18,828 miles at the beginning of 1878. The decline in 1876 and 1877 was continued in 1878. The railway mileage of the United States increased from 18,374 miles in 1855 to 35,085 miles in 1865, almost doubling, the civil war preventing a greater increase; but in 1873 the large mileage of 1865 was fully doubled, the number of miles then in operation being 70,311. In one year alone, 1871, no less than 7,608 miles were constructed. But from 1873 to 1877 only 8,897 miles were constructed, an average of a little more than 2,200 miles in four years. The average for the eight years from 1865 to 1873 was over 4,400 miles annually. The mileage for 1878 was about 2,600 miles.

Increase of railway mileage in Great Britain: 1855–1873, 1878.

Germany: 1855–1876, 1878.

United States: 1855–1865, 1878.

Construction in 1871.

1873–1877.

1865–1873.

Iron statistics.

To show how rapidly the iron industry alone was developed in the years immediately preceding the beginning of the present depression, I give the statistics of the world's production of pig-iron in each of the years 1855, 1872, and 1873, as follows: 1855—6,889,906 English tons; 1872—14,470,358 tons; 1873—14,706,459 tons. The production of 1855, it is seen, was more than doubled in 1872, a period of only seventeen years. This progress could not be expected to continue, and accordingly we find that in 1873 the production was only slightly in excess of that of 1872. In 1873 production reached its maximum, and since then it has steadily declined, the figures given in the beginning of this report

World's production of pig-iron.

1855, 1872, 1873.

Decline since 1873.

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showing a present annual production of only 13,807,725 tons. Stated more emphatically, the annual production of pig-iron, which more than doubled between 1855 and 1872, has declined almost a million tons from 1873 to 1878. *Causes of the general business depression.*

While the fever for building railroads was everywhere at its height another influence was actively at work to assist in destroying the prosperity of the iron industry by destroying, to a large extent, the demand for iron itself. A revolution involving the general substitution of steel for iron had been commenced, and so popular did it become that all the leading countries were soon engaged in promoting it. The Bessemer process and the open-hearth process for converting iron into steel at first helped only to meet a universal demand for both iron and steel, but when the merits of these processes became fully known and works devoted to them were established in many places, they gradually wrought a diminution in the hunger for iron, especially iron rails, and contributed greatly to precipitate the depression in the iron industry, and in all industries more or less dependent upon it. The new processes not only rendered useless hundreds of iron establishments which had been called into existence by the wants of new railroads and the exigencies of war, but they gave to the world products of greater durability than iron at approximately the same cost, thus decreasing the demand for iron ore, coal, and other raw materials which are common to the manufacture of both iron and steel. They did more than this: they almost wholly destroyed the large demand that had existed for years for finished-iron and for heavy iron machinery for the construction of blast furnaces and iron-rolling mills.

Substitution of steel for iron.

Rendered many iron establishments useless.

Gave products of greater durability.

We have here four leading causes of the world-wide business depression of the past few years: Destructive wars; the general substitution during the past twenty years of labor-saving machinery, and of more rapid processes of manufacture; the culmination of the fever for building new railroads; and, lastly, the partial destruction of the world's iron industry by the revolution created by the introduction of the Bessemer and open-hearth processes. These causes of depression have operated with almost equal force in countries engaged in war and in countries which were not so engaged, in countries which had an inflated currency and in countries which did not have it; in countries largely engaged in manufactures and in countries only slightly engaged in them. But, of all the countries visited by the hard times of the past few years, those least injuriously affected, and possessing to-day the brightest prospects for an industrial future, are the two

Resumé of the four causes of the general depression.

The countries least affected and most rapidly recuperating are France and the United States.

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which have most protected their home industries, the two great republics, France and the United States.

I now reach the proposed inquiry into the present condition of the iron and steel industries of Europe.

Condition of the European iron trade.

PRESENT CONDITION OF THE EUROPEAN IRON TRADE.

Austrian panic of 1873.

Check to railway building and iron industry.

After the Austrian panic of 1873 the building of railroads in the Austrian Empire received a severe check, the production of pig-iron and iron rails materially declined, and the imports of all iron and steel also greatly declined. The Bessemer steel industry of Austria has been very slowly developed, but its development has almost sufficed to destroy the Austrian iron-rail trade. In 1878 the country had not recovered from the depression which began in 1873, but it was adhering, and has since determined to adhere, to its protective tariff, through which its iron and steel manufacturers are supplying the limited demand that exists for their products, and its other manufacturers are secured the virtual possession of the home market.

Protective tariff.

German prosperity, 1871–1873.

The results of the business depression have been far more disastrous in Germany than in Austria. For about two years after the close in 1871 of her war with France, Germany was prosperous. Labor was in demand, and wages and prices advanced. But in 1873 symptoms of a decided reaction were manifested, and in that year the prosperity of the German iron and steel industries culminated, and it has since continued steadily to decline. This reaction would not have been so severe as it has been if the German Government, in an excess of generosity which is unaccountable, had not at the beginning of 1877 removed all duties on foreign iron and steel, thus increasing the severity of foreign competition at a time when domestic manufacturers of iron and steel were struggling with other causes of trade depression. A German statistical authority last year summarized as follows some of the consequences to the German iron trade of the reaction which commenced in 1873:

Reaction of 1873.

Decline.

Removal of protective duties in 1877.

Statistics of the iron trade and contraction 1872–1876.

"Between 1872 and 1876 the number of iron mines in operation in Germany, including the Grand Duchy of Luxemburg, declined from 1,341 to 1,026, and the number of miners from 39,421 to 28,138. Within the same period the number of furnaces in blast fell from 348 to 297, and the workmen employed from 26,111 to 20,500. Between April, 1873, and April, 1877, the number of workmen employed by 22 of the principal companies engaged in the iron trade (excluding Krupp) fell from 27,700 to 14,600. Within the same period the value of the stock of the Phœnix Company fell from 16,200,000 marks to 4,860,000 marks; of the Hörde Company from 15,000,000 marks to 3,210,000 marks; of the Bo-

Loss of values.

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chum Company from 15,000,000 marks to 3,375,000 marks; of the Dortmund Union Company from 41,400,000 marks to 2,070,000 marks; and of the Donnersmarkhütte Company from 18,000,000 marks to 3,906,000 marks. Of 32 companies, whose united capital amounted to £15,600,000, only six showed any dividend whatever for the year 1876, and the aggregate accounts published for that period showed a balance of loss on the year's operations of £359,000 on that capital, as compared with a loss of £195,000 for the previous year."

Condition of the European iron trade.

Loss of values in German iron interests.

A consular report to the United States Government in May, 1878, stated that in Westphalia at that time all manufacturers were "living on their capital, working away with yearly losses, waiting for the arrival of better times." Another consular report from Brandenburg, written about the same time, stated that "the returns of the great railway companies for the first quarter of the year show again diminished receipts, both for goods and passengers, and the stockholders in some cases will receive no semi-annual dividend." A German newspaper of recent date contains the following statement: "The Borsig Locomotive and Machinery Works, one of the proudest monuments of the iron trade of Germany, are, it is reported, about to be closed for an indefinite period. For some time past they have had to be kept going out of savings, and this the trustee of the Borsig estate declines to continue to do any longer. The works have been conducted at a loss for so many years in succession that they threaten to swallow up the entire estate." It need scarcely be added that both wages and the prices of manufactured products have greatly fallen in Germany since 1873. In the beginning of that year, it is stated, a passenger locomotive would bring £3,420, and is now worth only £2,225; first-class passenger cars have fallen from £750 to £450; second-class from £712 to £420; third-class from £402 to £260; fourth-class from £309 to £22. While in 1873 German manufacturers were called on to supply 332 locomotives, 924 passenger cars, and 4,006 freight cars, the orders in 1878 embraced only 68 locomotives, 336 passenger cars, and 1,901 freight cars. The depression in all manufacturing industries was supposed to be at its height in 1878. Many workmen were unemployed, and the general distress was very great, but this the government was endeavoring to alleviate.

Consular reports of condition of German iron trade.

Closing of the Borsig Locomotive and Machinery Works.

Decline in prices of rolling-stock.

Orders for rolling-stock, 1873, 1878.

The wonderful recuperative power which France displayed after the close of the war with Germany was illustrated in the revival of her iron and steel industries, but of late much difficulty has been experienced in maintaining the steel as well as iron establishments of France in operation; and, but for the strongly protective policy of the country,

Recuperative power of France.

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Condition of the European iron trade.

which has many forms, the difficulty would have been much increased, and financial and social distress would have been general. But France not only maintains high duties on foreign manufactures: she still further protects her home manufactures by doing her utmost to furnish them with employment. The building of railroads, for instance, has been greatly promoted by the government, and in the supply of rails and other material for new and already constructed railroads it is insisted that home products shall be preferred. The close relations which the government sustains toward the railroads makes it possible to have its wishes respected. Notwithstanding the help of the government, however, many iron and steel works of France, chiefly iron-rail mills and blast furnaces, were not employed in 1878. Prices have fallen to a very low standard, Bessemer steel rails having recently been reduced from $40 to $35 a ton, and ordinary bars at Paris to 147½ francs, or $28.47 a ton. The wages of labor are also very low. A French journal which is recognized as an authority stated at the beginning of 1878 that "production is beyond consumption; production has been too rapid, and must wait until an equilibrium has been established." It is worthy of note that the French iron and steel and other industries were not stimulated into activity by an inflated currency, as was partly the case in Austria and Germany, but that they have reached the point of development stated by the French journalist in defiance of a positive contraction of the currency, resulting from the payment of the heavy indemnity to Germany.

Protection and employment of native industries of France.

Decline in prices.

Wages.

Disadvantages of poor quality of ore and coal.

French iron and steel makers have had great natural disadvantages to contend with. Although there is no scarcity of native ore and coal, their quality is not usually the best that could be desired. The coal is generally very impure, and requires to be washed before it is coked; the ore is not well adapted to the manufacture of steel. Large quantities of both coal and ore are imported for use in French iron and steel works, and, owing to inland transportation, their original cost is greatly enhanced. It is only in consequence of low wages and long hours and by the practice of the utmost economy in all details that France is enabled to manufacture iron and steel at prices approximating those which prevail in neighboring countries.

Importations of ore and coal.

Rigid economy in all details.

Belgian iron and steel industries.

The Belgian iron and steel industries were not so generally depressed in 1878 and immediately preceding years as those of Austria or Germany or Great Britain, the degree of depression they experienced corresponding more nearly to that of the French iron and steel industries. With a

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great effort, and with the help of orders from the Belgian Government itself, nearly all of the iron and steel works of the kingdom, with the exception of blast furnaces, were kept in operation, although many were not operated to their full capacity. It has been partly through frequent reductions in wages that the Belgian ironmasters have kept their works in fair activity, and have been enabled, as has been officially stated by the secretary to the British legation at Brussels, "to buy pig-iron in England, pay for freight, and deliver the same iron manufactured into beams and girders in the most central parts of England, or even in the heart of the iron districts, at a lower price than it can be made by English firms on the spot." Belgium will continue to be a formidable competitor with other countries in supplying the iron and steel markets of the world.

Condition of the European iron trade.

Works kept in operation by government orders and extremely low wages.

Competition with England.

The iron and steel industries of Russia have not suffered from over-production, as they have not in late years fully supplied the home market. The recent purchase in the United States by Russia of four iron steamships and forty locomotives indicates this truth very plainly, if other statistics of Russian imports did not. Russian iron and steel manufacturers have had much to contend with in the poverty of the people, in the unsettled political condition of Russia, in the lack of sufficient means of communication, in the small consumption of iron and steel, except for railway and military purposes, and in the want of skilled workmen, especially for the development of the coal deposits of the country. The inducements to embark in the manufacture of iron and steel are not such as usually exist in other civilized countries. Russia is not conspicuously a manufacturing country, although she has certainly made rapid advances in late years in supplying her own wants. Her export trade in manufactured products is very small, and her imports are large. I do not look for Russia to recover rapidly from the effects of her war with Turkey; but she may be expected to strive hard to supply her own wants for iron, steel, and other manufactured products, and to exhibit a constantly diminishing demand for like products of foreign manufacture.

Russian iron and steel industries.

Purchases in the United States.

Difficulties:

Poverty.

Unsettled political condition.

Lack of railways and of skilled workmen.

Exports small and imports large.

There have of late been many financial failures in the ranks of Swedish iron and steel manufacturers, and many works have been closed. Production has been practically stationary for years, although the number of modern iron and steel works has in the mean time been increased, especially Bessemer steel works. But other countries can make Bessemer steel cheaper than Sweden, and but little of this

Sweden.

Production stationary.

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Condition of the European iron trade.

Sweden.

product that she makes is exported, and she makes but little. With the increased use of Bessemer and open-hearth steel in other countries the demand for Swedish iron has declined, even for her best brands for conversion into crucible steel. Swedish iron and steel makers are thus placed between two fires; they are deprived of a portion of the home market through the absence of protective duties, and they cannot make either iron or steel at prices sufficiently low to enable them to become formidable competitors with other makers in foreign markets. I can see but little prospect for an improvement in the Swedish iron and steel industries, and none whatever so long as the Swedish tariff remains as it is.

Bessemer and open-hearth steel diminish demand for Swedish iron.

Objectionable present tariff.

Italian and Spanish iron and steel industries.

The Italian and Spanish iron and steel industries are not of sufficient importance to call for further remark concerning their present condition than to state that, small as they are, they are not equal to the supply of the home demand for iron and steel. Other countries, however, will probably not be called upon to supply large quantities of these products to these countries in the near future, for neither country is prosperous, both having suffered greatly from political troubles and from the want of that industrial enterprise which characterizes the northern countries of Europe. In supplying iron ore to more enterprising nations, both Italy and Spain will be likely to become more prominent from year to year. Norway, Switzerland, Portugal, and Turkey will not make much iron or steel, nor will they need much from any source.

Small demand, partly met by importation.

Large exports of ore.

Ebb of prosperity in British iron and steel industries.

The tide in the prosperity of the British iron and steel industries has ebbed with the refusal or inability of other countries to buy British iron and steel in the large quantities that were a few years ago required. The exports of these products have steadily declined from 3,382,762 tons in 1872 to 2,299,223 tons in 1878, and their value has declined from £37,731,239 in 1873, when the highest prices were obtained, to £18,393,974 in 1878. In 1870 the exports of British rails and rail-fastenings amounted to 1,059,392 tons; in 1878 they amounted to 441,384 tons. During the years intervening between 1872 and 1878 Great Britain greatly expanded her Bessemer steel trade, and the decline in the aggregate quantity and value of her iron and steel exports is therefore all the more significant. As a result of this decline, many of her blast furnaces and rolling-mills have been closed, and not a few of their owners have been bankrupted. The iron rail trade of Wales and Cleveland has been pronounced by British writers to be "dead." Of 6,662 puddling furnaces

Decline of exports.

Iron-rail trade of Wales and the Cleveland district.

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Condition of the European iron trade.

from which returns had been obtained at the close of 1878 there were only 3,616 in operation. Of 977 blast furnaces existing at the close of the same year there were only 459 in blast. The production of pig-iron in Great Britain attained its maximum in 1872, when 6,741,929 tons were made; in 1878 the production fell to about 6,300,000 tons, and the stocks of pig-iron on hand at the close of the year amounted to 679,000 tons in Scotland, and to 337,337 tons in Cleveland. In 1873 the Cleveland district manufactured 324,420 tons of iron rails; in 1878 only 21,000 tons were manufactured. The price of Scotch pig-iron fell from 145*s.* in 1873 to 42*s.* 3*d.* in 1878, which was the lowest price reached during the past twenty-six years. It was stated at the close of the year that "undoubtedly the year 1878 was the most gloomy and unsatisfactory ever experienced by the iron trade of Scotland." The price of good forge pig-iron in Cleveland had fallen to 34*s.* 6*d.*, or $8.40, in December, 1878. Alluding to this price, an English technical journal has remarked that "it does not require a very powerful intellect to establish the stern, pitiless fact that at such a price the manufacture of pig is carried on at an infinitesimal profit—if, indeed, at any profit at all." The price of best Staffordshire bar-iron fell from £16 15*s.* in 1873 to £7 10*s.* in September, 1878. The struggle for existence is so severe in the British iron trade that the Cleveland iron-masters have made serious inroads upon the pig-iron trade of Scotland, having supplied Scotch consumers with 303,176 tons in 1878, and it is announced that they "are prepared to make further sacrifices to keep up the deliveries into Scotland."

Furnaces out of blast.

Pig-iron production, 1872, 1878.

Cleveland rail production, 1873, 1878.

Fall in price of iron, 1873, 1878, in Scotland.

In Cleveland.

In Staffordshire.

The London "Times," in its issue for January 3, 1879, forcibly presented in the following summary the rapid development of the iron and steel industries of Great Britain during the past few years, and their present condition:

London "Times," January 3, 1879.

"The aggregate output of Bessemer steel in the United Kingdom during 1878 has not been short of 850,000 tons, while of open-hearth or Siemens steel the production has been at least 150,000 tons more, making a total output, in round figures, of about 1,000,000 tons of steel; whereas in 1870 the production of both was under 230,000 tons. During 1878 new steel works have been put into operation at Rhymney and other places, and considerable additions are now being made to existing works in different parts of the country. As Bessemer steel works increase and multiply, so must finished-iron works diminish in value and in number; and it is of considerable moment that this should be better understood than it is at the present time. The finished-iron trade of this country came to the front with extraordinarily large and rapid strides. In 1860 there were only 208 works for the manufacture of finished-iron in the United Kingdom. In 1864 this number was increased to 248; in 1872, to 276; in 1874, to 298; and in 1877, to 312.

Steel product, Bessemer and open-hearth.

Rapid extension of steel works.

Finished-iron works.

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Condition of the European iron trade.

The number of puddling furnaces employed in these works increased from 3,462 in 1860 to 6,338 in 1864, and 7,311 in 1872; but in the years 1874 and 1877 the number showed a slight decrease, owing to the growing depression of trade.

Rolling-mills.

Of rolling-mills at work in the United Kingdom, the number increased from 439 in 1861 to 866 in 1871, and 942 in 1876. This development was, of course, induced by the demand for rails and plates made upon us by other countries up to the close of the year 1873, when our former customers began more generally not only to supply themselves but to become our rivals in neutral markets. Within 15 years the resources of production in the manufactured-iron trade of the United Kingdom increased to the extent of 2,467,000 tons, an increase far in excess of any probable demands. Of the 104 new finished-iron works erected between 1860 and 1877 many have now been closed for three or four years, and others are falling into this category almost every day. In the north of England full a million and a half sterling invested in finished-iron works has been yielding no return for upwards of three years; and in Wales probably a larger capital has been altogether unproductive. In both districts many works are valuable only for the old bricks and scrap iron to be obtained by their demolition."

Manufactured-iron trade.

Finished-iron works.

Maintained production of pig-iron.

The production of pig-iron in Great Britain has been maintained at almost the standard of 1872 because of the very low prices at which it has been possible to manufacture it, thus permitting its exportation in large quantities to Germany, Belgium, and other countries. The decline in the British iron and steel exports has been in manufactured iron. To send abroad raw or half-manufactured iron products, with a constantly declining demand for finished-iron products, is a condition of the British iron trade which brings the least pecuniary profit with the least employment of skilled labor, but with the largest consumption of native wealth.

Overproduction of Bessemer steel.

Nor is the Bessemer steel manufacture of Great Britain prosperous. It is suffering to-day from overproduction. In destroying the British iron-rail trade it is not clear that it has not commenced to prey upon itself. Bessemer steel rails are now sold at the same prices as good iron rails, a Sheffield firm having recently accepted an order for 25,000 tons of steel rails for the Northeastern Railway Company at £4 9*s.* 6*d.*, or $21.78. Competition between the owners of Bessemer establishments in Great Britain is so severe that already many of these establishments have been virtually closed. I have just read in an English journal that "it is a fact that there are works which have not rolled a single rail since Christmas." One result is certain to follow the severe struggle that is now in progress in Great Britain; not only iron rails but also all forms of manufactured iron and even crucible steel of British manufacture must be driven more and more from British and foreign markets.

Low prices.

Closing of works.

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Condition of the European iron trade.

The extraordinary development of the British iron and steel industries which has been noted has been almost equaled by the rapidity with which other British industries have been developed since the close of our civil war. These other industries, too, have suffered from the effects of overproduction as severely as the iron and steel industries. During 1878 the total numbers of business failures in Great Britain was 15,059, an increase of 4,037 in comparison with 1877. In the undue development of British manufacturing industries and in the subsequent misfortunes which have overtaken them an inflated currency has had no part, and until recently a protective tariff has had no friends.

Undue development of industries.

THE PRESENT CONDITION OF LABOR IN EUROPEAN COUNTRIES.

Condition of labor in Europe.

Inseparably connected with the condition of the iron and steel and other manufacturing industries of Europe is the condition of European labor. In proportion as these industries have been depressed so has labor lost its opportunities or gone without sufficient reward. The working population of Europe which is employed to-day is in receipt of wages which compel the severest economy in personal and household expenses, and which are, with few exceptions, lower than the wages paid to them before the late era of industrial activity and speculation. The number of the unemployed, and of those who earn a precarious subsistence in employments to which they are unaccustomed, is in most European countries larger than has been known for many years, and is especially large in Germany and Great Britain. But for the maintenance on the Continent of large standing armies, which withdrew many thousands of skilled and unskilled workingmen from competition with their fellows, the number there would be so great as to endanger the public peace. A few illustrations will suffice to show the present condition of European labor in both manufacturing and agricultural districts, but particularly in the former.

Severest economy necessary

Number of the unemployed beyond all previous experience

Draft of able-bodied into the armies.

France.

In France, in May, 1878, the average daily wages of carpenters were $1; of masons, 75 cents; of painters, 95 cents; of shomakers, 60 cents; of tailors, 75 cents; of women employed in various mechanical occupations, from 35 to 60 cents; and of children similarly employed, from 10 to 35 cents. At Creusot, where the highest wages on the Continent are paid to iron workers, the net wages of puddlers, in 1878, were about $2 a day, and helpers received 75 cents.

Wages of mechanics.

Iron workers of Creusot.

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Condition of labor in Europe.

Wages in France.

At the blast furnaces at Saint Chamond, in 1878, an ash-wheeler received 50 cents a day, an ordinary laborer 65 cents, a fireman 70 cents, and engineers 70 to 90 cents. The average annual earning of French colliers, in 1872, were only 980 francs, or $189.14, and their earnings are now still less.

Miners.

In 1877 the French Mining Department gave the average wages earned by the men employed in all the coal pits and iron mines in France as being from about 1*s.* 9*d.* to 2*s.* 4*d.*, or 43 to 57 cents, per day of about 11 hours. In the same year

Report of Mr. Com'r Frederick Brittain.

Mr. Frederick Brittain, an English commissioner to inquire into the rates of wages then paid in France, reported that at an iron works visited by him he found the wages of the preceding six months to have averaged 4*s.* 6½*d.*, or 86 cents, per man per day of 11 hours; at several other iron works he found that the wages ranged from 2*s.* 6*d.* to 4*s.* per day

Machinists.

of 11 hours. In the machine shops at Lille he found that the wages paid were 2*s.* 2½*d.*, or 54 cents, per day for laborers, and 3*s.* 4*d.* to 3*s.* 9*d.* per day for mechanics, the day being 11 hours long. Since 1877 wages have been reduced in France, but they are still higher than are paid in most Continental countries. A recent consular report to our own

Average wages in France.

government places the average daily wages in France at 45 cents, and the amount of the annual revenue of a representative French family, composed of father, mother, and five children, one of which is old enough to work, at $179.20. Its average annual expense is estimated at $167, or $3.21 a week.

Belgium.

During the first half of 1878 the average daily wages of

Wages of colliers.

colliers in Belgium were 2.86 francs, or 55 cents, per day, which was a decline from 3.08 francs a year previously. The

Iron workers.

average wages of skilled labor in Belgian iron works had increased in 1872 to 11 francs per day of 11 hours, but in 1876 they had fallen to 5 francs, and in 1877 to 4 francs, and even to 3½ francs. The steam-hammer man receives 4 francs per day, and the puddler, who pays his own help, receives about $2 per ton of puddled bars. The secretary of the British

Wages, hours, and food of Belgian laborers.

legation at Brussels reports that "a Belgian laborer works from Monday morning at six o'clock until Saturday night at twelve without intermission, and lives on food on which a British laborer would starve."

Russia.

In Russia the wages of a peasant usually range from 14

Wages of peasants.

to 37 cents a day, and the wages of his wife or daughter from 7 to 14 cents. At Odessa the price of labor has reached the extraordinary height of 50 cents a day. Throughout Russia the average rate of peasants' wages is 25 cents a day for men, 12½ cents for women, and 37½ cents for a man and

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his horse and wagon. The products of the farm bring proportionate prices: A sheep 25 cents; a cow $3 to $4; and a horse $5. The luxuries of civilization are almost unknown to the peasants and working classes of Russia.

Condition of labor in Europe.

Value of farm products.

Austria.

The wages of skilled workingmen in Austria have been reduced about 20 per cent. during the last four years. The silk industry furnishes employment to many Austrian men and women. In 1871, when Austria was prosperous, first-class cocoon winders received $1.80 per week of 72 hours, and raw-silk winders received $1 per week of 60 hours. The Austrian State Railways employ over 12,000 men, women, and children. The wages of the men vary from 36 cents to $1.09 a day; the average wages paid to the women are 20 cents a day, and to children 16 cents a day.

Silk workers.

Mechanics and laborers.

Germany.

In Westphalia, in Germany, the wages of general workmen in iron and sheet ware works, in 1875, were $4.50 a week, and the wages of day laborers were $3.80 a week; in iron foundries molders received $4.64 a week and day laborers $3.90 a week, the week being composed of six days of 11 hours each. Agricultural laborers throughout Germany received from 31 cents to 53 cents daily, in 1878, if men, and if women about one-third less. Men laborers in towns received from 50 to 55 cents a day; women from 25 to 37½ cents; workmen employed on public works from 40 to 57 cents. In the Thuringian States carpenters, blacksmiths, masons, and bricklayers received from 55 to 62½ cents; tailors from 45 to 50 cents; railway brakemen from 40 to 45 cents, with an additional allowance of about $5 a month for mileage. In all the cases mentioned boarding is not included. In Brunswick, Germany, skilled workmen received from 48 to 76 cents a day, without board. At Bremen wages per week were as follows: Shoemakers, $2.50 to $3.75; carpenters, $3.75 to $5; tailors, $5 to $6.25; masons, $3.75 to $5; blacksmiths, $2.50 to $3; joiners, $2.50 to $3. The present rates of wages in Germany are from 15 to 20 per cent. lower than in 1876. As an illustration of the distress which prevails, the official statement has been made that the burgomaster at Coburg employed 200 laborers during the winter and spring of 1878 in laying out and grading an addition to the city cemetery, and paid each man 26 cents as daily wages upon which to keep body and soul together.

Wages of iron workers.

Agricultural laborers.

Town laborers.

Mechanics.

Wages at Bremen.

Laborers at Coburg in 1878.

Italy.

In Italy the average wages of masons, carpenters, smiths, and other mechanics are about 65 cents per day of 12 hours, the minimum being 50 cents and the maximum $1.20. Ordinary laborers on government railways are paid from 50 to 60 cents a day; conductors, engineers, and other railway

Wages of mechanics and laborers.

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Condition of labor in Europe. employés are paid liberal wages. Silk spinners (women) are
Silk workers. paid from 18 to 24 cents per day of 13 hours, including lodg-
Agricultural laborers. ing but not board. Agricultural laborers throughout Italy receive from 25 to 40 cents a day, without board, except in harvest, when they are paid from 60 to 70 cents per day of 15 hours.

Great Britain. In Great Britain the wages of labor have been repeatedly reduced during the past few years, and every week brings us telegraphic intelligence of still further reductions. One of the latest dispatches by cable states that "the reduction
Wages of Scotch colliers. of 12½ per centum in the wages of which the Fife and Clackmannan colliers have received notice will make their average wages three shillings a day, which is lower than for many years; but no serious opposition to the reduction is anticipated."
Miners. In October, 1878, the earnings of Scotch miners averaged 2*s.* 9*d.* a day.

Wages of British colliers and miners. The wages of British colliers, iron miners, and iron workers are lower now than they were before the recent rise in prices. The wages of Northumbrian coal miners are 15 per cent. below the level from which they had advanced, and a further reduction is impending. In Durham the price now paid per ton for mining coal is 1*s.* 10*d.*, and in 1871, before the rise, the price was 2*s.* a ton. Notwithstanding this reduction, notice of a still further reduction of 20 per cent. has been given to the Durham miners, and the surface laborers at the mines have been notified that a reduction of 12½ per cent. will be made in their wages, coupled, however, with a reservation that the wages of able-bodied men shall not be brought below 2*s.* 6*d.*, or 61 cents, a day. In the iron-mining industry in the north of England wages which in 1871 were fixed at the rate of 11*d.* per ton rose to 1*s.* 4*d.* per ton in 1873, and have now fallen to 10*d.*, from which it is probable that a penny per ton will shortly be taken. As far back as the summer of 1877 it was announced that the South Staffordshire coal trade was so depressed that but little more than half time was being made at the collieries, and that the earnings of the colliers did not average more than from 12*s.* to 14*s.* a week. The situation is worse to-day.
Puddlers. The price of puddling in England is now 7*s.* 6*d.*, or $1.82, a ton, and about one-third of this sum the puddler pays to the helper. In 1873 the price of puddling was 13*s.* 3*d.* a ton. The reduction to 7*s.* 6*d.* is therefore almost 44 per cent.

Wages of puddlers in the United States. In the United States the price of puddling, if I am correctly informed, is nowhere to-day lower than the highest English price in 1873, and at Pittsburgh it is $5 a ton, or almost three times the present English price. Other

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branches of British industry than the coal and iron trades have experienced a depression so severe, that the wages of workingmen employed in them have also been frequently and greatly reduced, but I refrain from giving details. In their efforts to force down wages the masters have been strenuously resisted by their workmen, but the former have been successful in every contest. During 1878 there were no fewer than 277 strikes in Great Britain; in 1877 there were 181.

Condition of labor in Europe.

Strikes.

Much destitution and suffering have prevailed among British workingmen and their families in consequence of the reductions in wages which have been noted, but the full force of the existing hard times in Great Britain has fallen upon the tens of thousands who have been thrown out of all employment and denied any wages. Upon this sad story I do not propose to enter further than to show that no relief has yet been found for the unemployed, and that the struggle for life itself is now very severe. Two recent cable dispatches show how great is the existing distress in one of the leading iron and steel manufacturing districts of England:

Destitution and suffering.

Struggle for life.

Sheffield.

"LONDON, *November* 20, 1878.—A state of appalling distress and destitution exists among the mechanics and laborers of Sheffield in consequence of the business depression. Hundreds of persons are living in tenements without clothing or furniture, which they have been forced to sell to procure food. They are without fuel and are dependent upon the charity of their neighbors for subsistence. The mayor has called a public meeting to devise measures of relief."

"LONDON, *February* 28, 1879.—The mayor of Sheffield stated at a meeting yesterday that in one district of that town there are 4,000 persons destitute and 400 families are actually starving. The relief fund, except about £800, has been expended."

Chester.

It is announced that at Chester, in February last, the guardians, in order to provide work for the distressed laborers, had given employment in stone-breaking, at 1*s.* 6*d.* a day, to as many as desired to apply for it at the workhouse. Relief committees and soup-houses are to-day found in most mining and manufacturing districts in England, Scotland, and Wales. The trades unions are assisting their unemployed members to emigrate to the United States and other countries, and English newspapers urge all the unemployed to emigrate if they can find the necessary means. It is mentioned, however, that "wholesale emigration has but partially mitigated the distress in the Cornish tin-mining industry, thousands of penniless women and children being left behind. Hundreds of men unable to emigrate are absolutely without employment. The distress has now exceeded the bounds of private liberality." The distress in England

Emigration.

Cornwall.

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Condition of labor in Europe.

is said to be more general and pitiful than that which accompanied the "cotton famine" in 1862.

Employment of women and children.

In all European countries women are engaged in many masculine employments, and children in employments to which they are unsuited. Of 5,887 persons employed in the iron mines of Sweden in 1876 there were 421 women and girls. At Creusot and other French iron-works women perform a large part of the labor about blast furnaces and above ground at the coal mines. All the work at the coal washers is done by them, and they are also employed in wheeling coal. French women work in the fields, performing the labor of men, and in some of the cities of France they may be seen cleaning the streets, digging cellars, and doing other work which in our country is only performed by men. Women and children, both boys and girls, work about Belgian blast furnaces, wheeling coal and ore, and also work in the coal mines. The government recently refused to exclude women and girls from the mines, but fixed the minimum age of boys working in the mines at 12 and that of girls at 13 years. In Italy, Austria, and Germany women work as regularly in the fields as do the men. In Wales they engage in many laborious outdoor employments. In England thousands of young girls are still employed in carrying clay in the brick-yards. The poverty of the working people of Europe, especially since the reaction in prices and wages a few years ago, is doubtless the principal reason why women and children help to do the work of men, the earnings of all the members of the family who can work being necessary to keep the wolf from the door. It will readily be inferred that the food, and clothing, and household comforts of the family of a European workingman are not such as the families of our well-to-do American mechanics and farmers are accustomed to. A condition of society which requires such sacrifices and imposes such privations is not desirable in this country.

Women as furnace hands and colliers.

Field work.

Miners.

Women, boys, and girls in Belgian mines.

Brick carriers.

Poverty, discomfort, and filthiness.

American competition in foreign markets.

AMERICAN COMPETITION IN FOREIGN IRON AND STEEL MARKETS.

A study of the present condition of the iron and steel industries of Europe and of the condition of European labor naturally leads to the inquiry whether the iron and steel manufacturers of the United States can compete in foreign markets with industries so depressed and with labor so poorly rewarded, and to the further inquiry whether they could hold possession of the home market if the protection now afforded by duties on imports were withdrawn. It is

Inquiry as to competition in countries where labor is so cheap.

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clear to me that if the crude and coarse forms of iron and steel be considered, such as pig-iron, bars, rails, plates, sheets, and beams, neither of these inquiries can be answered in the affirmative.

American competition in foreign markets.

It is well known to every well-informed person that the prices of iron and steel in this country never were so low as they are to-day, and that these low prices are the result of the severest home competition which has ever been experienced. In the struggle for the possession of the home market which the financial panic of 1873 precipitated and entailed upon our iron and steel manufacturers, they have made use of every resource that science and skill and economy could suggest as a cheapening influence. Improvements in machinery and in processes have been made at great expense; old methods of manufacture have been modified or discarded; search has been made for better and cheaper raw materials; wages and profits have been reduced. Many manufacturers have resorted to all the expedients here named, by which they hoped to keep their establishments in operation, and yet have been unable to maintain their hold on the market, and with the failure to do this have retired from business or been forced into bankruptcy. With the knowledge of this severe competition and its effects before us, it is not a reasonable supposition that prices can go much, if any, lower than they now are. And yet there are many countries in Europe in which both iron and steel are made much more cheaply than in the United States. Competition in these countries has been as severe as in this country; bankruptcy has followed bankruptcy; wages, always lower than in the United States, have been reduced and reduced again. Special natural advantages, joined to low wages, have combined with a slackening demand to bring the prices of iron and steel in Europe down to a level which has never before been reached.

Our present low prices the result of severe home competition.

Improved and cheapening processes.

Difficulties and disasters.

Our present low prices exceed those of Europe.

Present prices in Europe low beyond previous example.

Among the natural manufacturing advantages referred to, cheap transportation is most prominent. In the United States our best ores are found at long distances from the fuel that is needed to smelt them; much of the pig-iron manufactured is necessarily made at long distances from the works which refine it into finished iron and steel, and even the finished product is usually transported hundreds of miles before it reaches the consumer. In Europe the ores and fuel are usually found in proximity to each other and to finished-iron and steel works, or can be cheaply transported. The territorial extent of the leading manufacturing countries of Europe is small indeed when compared with the wide extent

Cheap transportation in Europe.

Distance of our best ores from the fuel.

Proximity of ores and fuel in many parts of Europe.

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American competition in foreign markets.

of our own country, and the mineralogical riches of Europe are distributed with remarkable evenness. Hence railroad transportation is not there the tax that it is in this country, and canal and ocean transportation still more cheaply serve the European manufacturer by bringing to him raw materials or taking his finished product to a market. Great Britain alone has over 4,000 miles of canal, and her facilities for receiving and shipping raw materials and manufactured products by sea are unequaled.

Great advantages of transportation in Great Britain.

I. Lowthian Bell.

My distinguished friend, Mr. I. Lowthian Bell, M. P., in his report to his government on the iron and steel resources of the United States, as represented at the Philadelphia Exhibition, saw and recognized the influence of long lines of transportation in adding to the cost of American iron and steel products. He said:

Proximity of ore and coal in Great Britain.

"The vast extent of the territory of the United States renders that possible which in Great Britain is physically impossible; thus it may and does happen that in the former, distances of nearly 1,000 miles may intervene between the ore and the coal, whereas with ourselves it is difficult to find a situation in which the two are separated by even 100 miles."

The cost of finished iron and steel in the United States, increased one-third by unavoidable transportation.

This is a frank statement of facts, but I may add to it another important fact, which the books of leading manufacturing companies will verify, that fully one-third of the cost of all the finished-iron and steel that are made in the United States is created by unavoidable railroad transportation. If it were possible to make iron and steel in this country without paying this tax to the railroads, there are few railroads that would pay a dividend to their stockholders, and the building of new railroads would practically cease, for all our leading railroad companies derive a large part of their revenue from the transportation of the ore, coal, coke, limestone, pig-iron, and finished-iron and steel used at or produced by our iron and steel works. With the cost of transportation reduced fifty per cent., and the price of labor reduced to the European standard, this country could make iron and steel as cheaply as Europe, but neither result is possible, and neither is desirable. It is not wise statesmanship, nor true economy, nor humanity worthy of the name that seeks to cheapen any product by making capital a coward and labor a slave. But labor in this country cannot be made the slave that it is in Europe, if legislation would seek to force such a result. Its greater intelligence, its political privileges, and its wider opportunities forbid the degradation. It would speedily reverse at the ballot-box all hostile legislation, and millions of fertile and

Railway revenues derived therefrom.

We do not seek to follow the European standard.

Dignity and power of labor in the United States.

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unbroken acres in the West will long afford an outlet to surplus labor in our manufacturing districts.

American competition in foreign markets.

We will doubtless continue to increase our exports of such products as hardware, edge-tools, and light specialties, in the production of which American ingenuity has given us an advantage; but bulky iron and steel products, which are manufactured with materials and by the employment of skill that Europe possesses in common with ourselves, we cannot export in appreciable quantities, even to our nearest neighbors. A reference to the statistics of American exports will show that we cannot. Our iron and steel manufacturers will do well to abandon the hope that such a result is possible. The statesmen of the country need not look for these manufacturers to swell our foreign commerce with their products. The home market is all that they can supply under existing conditions, and in supplying it with good iron and good steel at the lowest prices ever charged to American consumers they will find sufficient employment for all their energies and perform a service to their countrymen far greater than could follow an uncertain struggle with overcrowded countries for the supply of foreign markets.

Our exports of hardware and tools likely to continue.

We cannot export bulky iron and steel products.

Our opportunities for foreign commerce necessarily limited.

I trust that no man, be he statesman or manufacturer, will be deluded with the thought that our most formidable manufacturing rival, Great Britain, will cease her efforts to regain possession of our home markets. Her manufacturers of cotton, woolen, iron, steel, and other products are forcing labor to accept as low wages as are paid in the poorest country on the Continent of Europe; and, with the many natural and acquired manufacturing advantages which they possess, they will in a little while set at defiance the manufacturing advantages of all other countries. Temporarily under a cloud, because of the progress made by other countries in developing their own resources, or because of their financial inability to continue the large orders once given to her manufacturers, Great Britain will make a desperate effort to emerge from it by seeking to undersell the whole world. Against this fresh assault most Continental countries, and some British colonies, will defend themselves with protective tariffs, and if this country would not see many of its leading industries overthrown it must resolutely adhere to the revenue policy which has developed those industries and which is enabling the country to-day to enter with hope and confidence upon a new era of prosperity. I would not excite unnecessary fears, but my duty to my country-

Great Britain's ceaseless efforts to regain possession of the American market.

Will attempt to undersell the whole world.

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American competition in foreign markets.

men would not be performed if I did not warn them of the danger which will constantly impend over their industrial welfare so long as a powerful rival is able to force its labor to the lowest point of human endurance, and untiringly seeks by diplomatic and other methods to force the products of that labor upon countries which do not want them, and which, like Spain and Turkey, will be impoverished if they buy them.

DANIEL J. MORRELL,
Additional Commissioner.

[In the collection of the historical and statistical information contained in this report I have had the valuable assistance of Mr. James M. Swank, the Secretary of the American Iron and Steel Association, and this assistance I thankfully acknowledge.

D. J. MORRELL.]

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HELIOTYPE PRINTING CO., BOSTON.

CUPIDS AT SUPPER.

Pâte-sur-pâte plaque, by SOLON.

[Plate I.]

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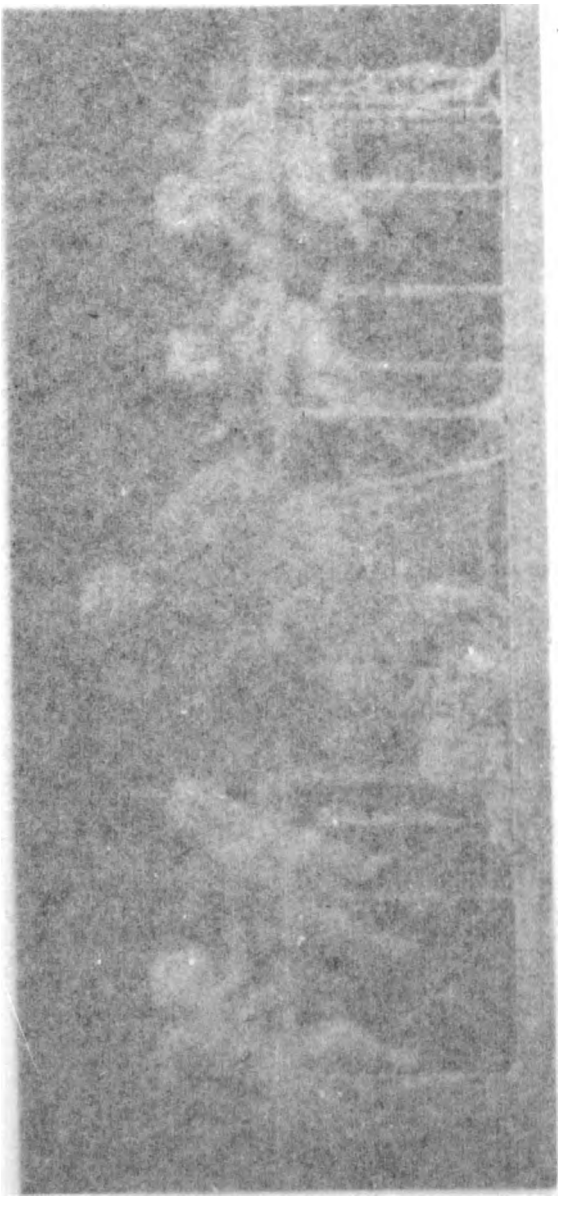

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CERAMICS.

WILLIAM P. BLAKE.

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[Extract from the Official Classification.]

CLASS 20.—POTTERY.

Biscuit ware, hard and soft paste porcelains.

Fine earthen ware with colored glazing, etc. Earthen-ware biscuit. Terra cotta. Enameled lava. Bricks and tiles. Stone ware.

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CERAMICS.

INTRODUCTORY AND GENERAL VIEW.

Display exceeded all former exhibitions.

The display of ceramic products at the Paris Exhibition of 1878 was the largest and most complete of any yet made at the great international exhibitions. It far exceeded in extent, diversity, and quality the display made at Paris in 1867, or at Vienna in 1873, or at Philadelphia in 1876. As an exhibit of the condition of the potter's art at the present day it was magnificent, comprehending, as it did, every variety and ramification of product, from the humble brick and tile to the wonderful vases of Sèvres and the inimitable plaques of Solon.*

Advance in quality and art-merit.

The great advance in the quality and art-merit of the products was very satisfactory to those who have specially observed the progress of this industry for the last decade, or since the Exhibition of 1867. This advance is not alone in the improvement and combination of the materials forming superior bodies, glazes, and enamels, but in form, color, and novelties in design and adaptation to the advancing tide of artistic decoration. Art is making its impress upon the clay in many more ways than formerly. The capacity of the material is becoming more and more appreciated. The chemist has helped to enrich the palette of the painter in vitrifiable colors and to render possible effects of color and shade before unattainable. Glazes are now compounded that flow into and preserve every detail of the stroke of the artist's brush, without a blur or fusion, heightening the desired effect as varnish brightens a painting on canvas. The bold and striking effects of incised lines are better understood, and engraved clay, or *grafito* work, preserves the conceptions of some of our ablest artists. Again, the clay is built up in relief upon a background of any desired color with effects rivaling the cameos of the glyptic art. Again, the process is partially reversed, and the design is partly scooped from the clay and is then filled with enamels of the desired color, which, when fused, form a species of cloisonné. Clay and enamels lend themselves most fittingly to decora-

New and striking methods and effects.

Grafito.

Pâte-sur-pâte

Cloisonné.

* See frontispiece and article on *Pâte-sur-pâte; infra.*

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tion in the hand of the habile artist, who, to win the best results, must unite the qualities of painter, sculptor, and potter.

Appreciation of the potter's art.

The rapid expansion of the potter's art finds explanation in the increased appreciation of its products by the people under the advancing culture of the public taste, and the sharp competition which it engenders amongst the potters for the production of more and more attractive novelties.

The ceramic mania.

The mania for collecting, comparing, and studying the examples of the potter's art of all countries and periods has exerted a great influence in promoting an intelligent comprehension of it.

Collections.

Public collections have been multiplied and enriched, serving alike for the education of the potter and his patrons. It is an art which, beyond all others, requires the objects themselves for illustration. No delineation by the graver, no reproduction of light and shade by photography, and no process of color-printing can give the luster of the enamel or the translucent beauty of porcelain.

The most enduring of art memorials.

They must be seen to be appreciated. No other form of art creation so well endures the ravages of time and survives the records of man. Collections of pottery thus have a manifold value, not alone technical and æsthetic, but they are full of ethnographical and historical teaching. The great exhibitions are powerful factors to the advancement of the art, by bringing the latest achievements of the potters to the notice of the world under circumstances inviting comparison and description. The best examples find their way into the collections of connoisseurs or the cases of public museums.

Influence of art exhibitions.

In this art, as in all others, the international exhibitions are powerful educators. It is by *seeing* that the mass of mankind is stimulated to learn. The millions who witnessed the unrivaled collection of ceramic products at Paris could not fail to be taught by it. Any attempt at description fails to convey an adequate idea of it. It is a consolation that some of the best examples were secured for the museums of Great Britain and the Continent. A few found their way to America.

South Kensington Museum.

The collection at South Kensington has been greatly enriched from the successive exhibitions and other sources.

Persian pottery.

The collection of Persian pottery is enormous and of immense value.

Japanese.

The treasures of Japanese pottery of all periods are unequaled elsewhere. In gathering this collection together the powerful aid of the Government of Japan has been successfully invoked, and examples of work from all the noted potters of Japan may now be found admirably

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classified and arranged in London. Many of the rarest and most precious pieces of ancient Japanese pottery are found there.

Effects of the Japanese style.

The influx of the unending variety of forms of Japanese porcelain and *faïence*, in collections and in commerce, has had a great effect upon the taste of the public and the art of the period. It is not more strongly shown than in the decorative pottery of the day, whether of French or British manufacture. The spirit of Japanese decorative art has been caught in both countries, as the ceramic products at the exhibition stalls abundantly proved. In this result we have a repetition of the influence exerted a century ago upon potting in Europe, when in fact the importation of "china" stimulated Europeans to undertake the manufacture. Thus the same influences which served to plant and force into activity the manufacture of porcelain in Europe have, since the opening of trade with Japan by the United States, a century later, vivified and greatly advanced the art.

Original stimulus in porcelain-making from China.

British pottery.

The British potting interests have not only had the beneficial influences of the influx of Oriental wares; they have been spurred on to greater and greater achievement by the Continental potters. There has been a spirit of rivalry which has borne much fruit. It dates back and owes its existence to the famous Exhibition of 1851, and was strengthened in 1862 and 1867. The advance of Great Britain in the manufacture of art pottery and porcelain has been wonderful since 1851, placing the country now in the front rank of potting nations, and making it the rival and competitor of France.*

Great advance since 1851.

Now in the front rank.

Recognition of services of French exhibitors.

The thanks of the writer are due to a great number of the French exhibitors, who, in response to his requests, gave much interesting information in detail concerning their products and establishments.

Prof. Archer on the influence of national exhibitions.

* Professor Archer, writing of the exhibition of 1873, on the influence of international exhibitions as records of art industry, says:

"Already the extreme ugliness which marked the attempts at decoration in our pottery and porcelain, glass, metal work, etc., at the commencement of the second quarter of the present century, and which called forth the pity, if not the contempt, of our neighbors, has passed away; everywhere may be noticed the dawnings of genuine taste, and in numerous instances a progress which places us on a level with foreign competitors." (*Brit. Vienna Report*, iii.)

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Chronicle of events in the history of pottery.

CHRONICLE OF THE PRINCIPAL EVENTS DIRECTLY CONNECTED WITH THE MANUFACTURE OF POTTERY.

B. C. 600 to 900 years. Manufacture of enameled bricks in Nineveh and Babylon. The Museum of Practical Geology, London, contains several specimens of enameled bricks from Babylon, dating some 600 to 900 years B. C.

B. C. 185. Manufacture of porcelain supposed to have commenced in China between this date and A. D. 87, during the Han dynasty.

A. D. 600. Porcelain in common use in China, and supposed to have reached its greatest perfection about the year 1000.

1115. Moorish tiles probably introduced in Italy at the conquest of Majorca by the Pisans..

1200–1300. Colored tiles believed to have been in common use in Persia.

1273–1302. Earliest tiles of the Alhambra.

1310. Delft ware successfully manufactured in Holland.

Incised or grafito (*Sgraffito*) ware largely produced by the Italian artists.

1400. Luca della Robbia born, the sculptor, painter on *faïence*, modeler in bronze, and supposed to have been the first to employ stanniferous glazes in Italy.

Encaustic tiles manufactured in Great Britain, at Malvern Hills and other localities.

1475. Earliest date noticed on any piece of lustered majolica of the manufacture of Maestro Georgio. Fortnum considers a piece in the Sèvres Museum, dated 1489, to be the earliest piece of lustered ware on record.

1500. About this time Oriental porcelain was imported to Europe by the Venetians and Portuguese, and in the following century the Dutch imported great quantities.

1510. Bernard Palissy born about this date, at La Chapelle Biron, Perigord.

1540–1560. Manufacture of majolica in a flourishing state.

1540–1620. Flemish ware, commonly known as *Grès de Flandres*, in great esteem in Great Britain.

1580. About this date the earliest known production in Europe of pieces of porcelain in the laboratory of Duke Francesco de Medici at Florence.

1581. Soft porcelain discovered in Italy by Francis, Grand Duke of Tuscany.

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Chronicle of events in the history of pottery.

1585. Gold purple or precipitate of cassius discovered.
1589. Palissy died in confinement in the Bastile.
1671. Earliest efforts to manufacture porcelain in England, by Mr. John Dwight, at Fulham.
1674. Manufacture of pottery established in Liverpool before this date.
1680. Salt glazing said to have been discovered in Staffordshire by accident.
1690. Crouch ware first made by Burslem potters.
Dresden (Meissen) porcelain manufactory established by Augustus II, Elector of Saxony.
1706. Commencement of the experiments of Tschirnhaus and Böttcher, two alchemists in the service of the Elector of Saxony, leading to the production by Böttcher of the first hard or true porcelain in Europe, but of a dark color.
1709. White porcelain made by Böttcher.
1710. Böttcher appointed director of the manufactory at Meissen.
1715. White porcelain of good quality commonly made.
1720. Paintings on porcelain, and gilding, produced at Meissen.
1730. Josiah Wedgwood born at Burslem, England; died 1795.
Bow works, England, commenced manufacture of porcelain.
1731. Kandler, the sculptor, superintended the modeling of groups and figures at Meissen.
1744. St. Petersburg porcelain works founded by the Baron Ivan Antinovitsh.
1745. Cookworthy in a letter mentions that a person had discovered both kaolin and petuntse in the State of Virginia, and had made from them specimens of porcelain. The same party professed to have purchased the whole region from the Indians.
1747. Porcelain works of Blanquier, Vienna, Austria, purchased by the Empress Maria Theresa, and made an imperial establishment.
Porcelain works established at Neudeck, Bavaria.
1750. Decoration of earthenware and porcelain by transfer from copper-plate prints, believed to have originated with John Sadler, of Liverpool.
Swansea earthenware works established.
From about this date the true Sèvres *pâte tendre* was manufactured with habitual success.

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Chronicle of events in the history of pottery.

Manufacture of porcelain commenced at Berlin by Wegely.

1751. Worcester porcelain works established at Worcester, England.

Foundation of the Derby porcelain works, England, by Mr. William Duesbury.

1755. Discovery of kaolin in Cornwall, by William Cookworthy, whose attention appears to have been directed to the subject by a citizen of Virginia, in 1745.

Works established at Coxside, Plymouth, England, by Cookworthy and Lord Camelford, about 1755, soon after the discovery of the materials at Cornwall. Transferred to Bristol, 1774.

1756. Porcelain works removed from St. Cloud to Sèvres.

Manufacture of porcelain attempted at Lowestoft. 1770–1800 period of greatest prosperity. Works abandoned in 1802.

1757. Rockingham porcelain and brown ware made at Swinton, on estate of Charles, Marquis of Rockingham.

1758. Neudeck manufactory, Bavaria, transferred to Nymphenburg, near Munich.

1760. Louis XV became proprietor of the Sèvres establishment.

Isleworth pottery established by Joseph Shore, of Worcester.

1763. Frederic II bought the Berlin porcelain works and converted them into a royal manufactory.

1765. Discovery of kaolin in France, by Guettard, who gave an account of it in this year to the *Académie des Sciences*.

1766. Kaolin was found near Limoges, at St. Yrieix, in abundance and of good quality.

1769. Hard-body porcelain introduced at Sèvres manufactory.

1772. Porcelain of superior quality manufactured at the Shropshire potteries, under Thomas Turner, from the Worcester works.

1795. Pinxton porcelain works established near Alfreton, England. Closed about 1812.

Wedgwood died.

1796. The "Marcolini period" at Meissen commenced.

1800. Calcined bones introduced by Spode into the paste of his porcelain at Stoke-upon-Trent, England.

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Chronicle of events in the history of pottery.

1812. Inspection of the porcelain works at Meissen by M. Brongniart, on the requisition of Napoleon I. The greatest secrecy maintained until that time.

1813. Nantgarw (near Cardiff) porcelain manufactory established.

1840. Foundation of the tile manufacture of the Mintons, Stoke-upon-Trent, England.

1864. The Austrian imperial porcelain works discontinued.

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LIST OF THE JURY AND OF THE AWARDS GIVEN IN CLASS 20, CERAMICS.

CERAMICS.

List of the jury.

Jury in Class 20; Ceramics.

Messrs.	
ROBERT	France.
H. E. the Count WLADIMIR DZIEDUSZYCKI	Austria-Hungary.
DE LUYNES	France.
DUBOUCHÉ (A.)	France.
FRANKS (Augustus W.)	England.
GLÈVE (P. P.)	Sweden and Norway.
BERNABEI (Dr.)	Italy.
MOREAU (A.)	China.
KAWARA	Japan.
TUBINO (F.)	Spain.
LE CHEVALIER DE PORNER (C.)	Austria-Hungary.
LAMBERT	Belgium.
THOMSEN (Prof. A.)	Denmark.
BARRIAT	Persia, Siam, Morocco, Tunis, and Aunam.
SALVETAT	France.
PEULLIER	France.
MILET	France.
BARLUET	France.
JOURNAULT	France.
ROUSSEAU	France.
NILSSON	Sweden.
FISCHER	Hungary.

Awards in Class 20; Ceramics.

AWARDS.

GRAND PRIZES.

Diplomas of honor equivalent to a grand medal.

Grand Prizes.

The exhibits, collectively, of the Japanese exhibitors	Japan.
Cher (The manufacturers of hard porcelain of the Department of the)	France.
Limoges (The manufacturers of hard porcelain of the Department of)	France.
Sèvres Manufactory	France.

GRAND MEDALS.

Bapterosses (F.)	France.
Deck (T.)	France.
Mintons	England.

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GOLD MEDALS.

Gold medals.

Boch Frères.....Belgium.
Boch Frères & Cie.....France.
Boulenger (A.-J.-B.).....France.
Boulenger (H.) & Cie.....France.
Brown-Westhead (T.-C.), Moore, & Co.....England.
Champigneulle.....France.
Copeland (W.-T.) & Sons (*rappel*).....England.
Doulton & Co.....England.
Fischer & Mieg, Ludwig Meig & Rudolf Fischer.....Austria-Hungary.
Gibus & Redon.....France.
Gien (Faïencerie de), administrateur délégué: G. Gondoin.....France.
Gillet (E.).....France.
Ginori Lisci (Marquis L.).....Italy.
Gustafsberg Fabriks Intrese Senler.....Sweden.
Hache & Pépin, Lehalleur Frères.....France.
Haviland & Cie.....France.
Hiotiyen.....Japan.
Huart (P. d') Frères.....France.
King-teh-chen (Imperial Manufacture of).....China.
Kôran-Sha.....Japan.
Loebnitz (J.-P.).....France.
Miyagawa.....Japan.
Montagnon.....France.
Muller & Cie.....France.
Pickman & Cie.....Spain.
Pillivuyt (C.) & Cie.....France.
Pouyat (E.).....France.
Rorstrands Aktiebolag.....Sweden.
Shippo Kuaisha.....Japan.
Soyez (P.).....France.
Tuileries et Société de Construction de Wienerberg.....Austria-Hungary.
Viellard (J.) & Cie.....France.
Vion (D.) & Baury.....France.
Wedgwood (Josiah) & Sons.....England.
Worcester (The Royal Porcelain Works Company).....England.
Zsolnay (G.).....Austria-Hungary.

SILVER MEDALS.

Silver medals.

Arabia (Fabrique).....Russia.
Atelier d'Application de l'École Municipale des Beaux-Arts de Limoges.....France.
Aubry (J.).....France.
Barbizet Fils.....France.
Barreau (L.).....France.
Beau & Porquier.....France.
Bossot.....France.
Bouquet (M.).....France.

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Awards in Class 20; Ceramics. Silver medal.

Carr (James)	United States.
Castellani (T.)	Italy.
Chu-Pao	China.
Clauss (M.)	France.
Cool (Mme. de)	France.
Cybulski (C.)	Russia.
Dalpeyrat & Lot	France.
Damousse	France.
Daubron Frères	France.
Debacker (L.)	France.
Delaisse	France.
Demartial & Talandier	France.
Eichler	Austria-Hungary.
Ernie	France.
Gaidan	France.
Godin (J.) & Delaherche	France.
Gosse (P. Vve.)	France.
Ipsen (Vve.)	Denmark.
Kakimoto	Japan.
Kanzan (D.)	Japan.
Klammerth	Austria-Hungary.
Kopsch (H.)	China.
Kunzi Bendicht	Switzerland.
Lacroix	France.
Laurin	France.
Lefort & Jouve	France.
Lévy (C.) & Cie	France.
Macé	France.
Machereau	France.
Mafra (M.-C.)	Portugal.
Manuel Soto Tello	Spain.
Manufacture de Faïences de Saint-Clément	France.
Marounaka	Japan.
Mauger & fils & Letu fils	France.
Maw & Co	England.
Meyer	France.
Milet (O.) & Massier (C.)	France.
Minton, Hollins, & Co	England.
Mol (A. de)	Belgium.
Monnier (E.)	France.
Parvillée (E.)	France.
Pinder, Bourne, & Co	England.
Pinto Basto	Portugal.
Poyard	France.
Pull	France.
Sand & Cie	France.
Sazerat	France.
Schopin	France.
Schutz Frères	Austria-Hungary.
Simon & Cie	France.
Société Céramique de Maëstricht	Netherlands.
Société Industrielle et Artistique de Monaco	Principality of Monaco.
Spinaci (J.)	Italy.
Tanzan	Japan.
Thomas (A.)	France.

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Awards in Class 20; Ceramics.

Silver medals.

Tortat ..... France.
Tourteau (E.) ..... Belgium.
Turner (W.-M.) ..... China.
Ulysses-Besnard (J. J.) ..... France.
Valarino (Héritiers) ..... Spain.
Villeroy & Boch ..... Luxemburg.
Virerent Frères & Fils ..... France.
Wang-Taï, at Cholen ..... Cochin China.

BRONZE MEDALS.

Bronze medals.

Abé ..... Japan.
Adams & Bromley ..... England.
Allix (Demoiselles M. & B.) ..... France.
Alluand aîné (The heirs of F.) ..... France.
Avisseau (E.) ..... France.
Aubrée ..... France.
Barthe, de Galard, Clerc, & Cie ..... France.
Bender (Ve.) ..... France.
Benucci & Latti ..... Italy.
Blot (P.) ..... France.
Bodmer & Biber ..... Switzerland.
Boissimon (de) ..... France.
Brownhills Pottery Company (The) ..... England.
Campbell Brick and Tile Company ..... England.
Carrier ..... France.
Cellière ..... France.
Charbonnier frères ..... France.
Charlot fils ..... France.
Chevallier (Demoiselle) ..... France.
Chwan Mei ..... China.
Campagnie des Houillères de Höganas ..... Sweden.
Craven, Dunhill, & Co ..... England.
Cucurny (P.) (*rappel.*) ..... Spain.
Dange (F.) ..... Belgium.
Dartout ..... France.
Davignon (Me. Noëmi) ..... Belgium.
Delange (H.) ..... Italy.
Delin ..... Belgium.
Diffloth Père (A.) ..... France.
Dubousset Frères ..... France.
Dunoyer (Ve.) ..... France.
Écoles d'Art Industrial de Bombay ..... British Indies.
Edwards (J.) ..... England.
Ernst Bernardt ..... Austria-Hungary.
Escudero (P.) ..... Spain.
Eyer (C.) ..... Switzerland.
Fabrique de Sacavem ..... Portugal.
Far y Nadal (B.) ..... Spain.
Ferniani (Comte A.) ..... Italy.
Fourmaintraux Courquin ..... France.
Fow Loong ..... China.
Gallé ..... France.
Gastaldo (J.) ..... Spain.

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Awards in Class 20; Ceramics.	Gannet, Mari, Guirard, & Cie	France.
	Gauvin	France.
	Gille	France.
	Girault (P.)	France.
	Gossin	France.
	Gouvernement (Le) du Maroc	Morocco.
	Guyane Française	France.
	Hattori (T.)	Japan.
	Houry (Ch.)	France.
	Howell, James, & Co	England.
	Hubaudière (De la) & Cie	France.
	Hutan (J.-B.-E.)	France.
	Kakato	Japan.
	Kato (G.)	Japan.
	Kato (K.)	Japan.
	Kawamoto (H.)	Japan.
	Kawamoto (M.)	Japan.
	Klotz	France.
	Koumamoto	Japan.
Bronze medals.	Konnick (De) Frères	Belgium.
	Labarre (Ve.)	France.
	Lafont (M.)	France.
	Langeron (P.)	France.
	Lefront (A.-T.-M.)	France.
	Levy (Ch.)	France.
	Lizo (J.)	Portugal.
	Majorelle (A.)	France.
	Mallato (M.)	Portugal.
	Ott & Brewer	United States.
	Pannier-Laoche & Cie	France.
	Perez-Moneo (A.)	Spain.
	Peyrusson	France.
	Pinot (Ve.)	France.
	Poiret (R.)	France.
	Puisoye (Mlles. M. & W.)	France.
	Revol (G., Père & Fils)	France.
	Rigal & Sanejouand	France.
	Robillard	France.
	Roy (G.)	France.
	Sa Majesté Impériale le Shah de Perse	Persia.
	Samson Fils aîné	France.
	Schenk Trachsel	Switzerland.
	Sergent (T.-V.)	France.
	Simizou (O.)	Japan.
	Simizou (R.)	Japan.
	Simpson (C. L.)	China.
	Slowak (F.) aîné	Austria-Hungary.
	Société des Fabricants Réunis de Vallauris	France.
	Société des Kaolins de Limoges et de la Haute-Vienne	France.
	Stiff (J.) & Sons	England.
	Takahashi	Japan.
	Tani (S.)	Japan.
	Thibault	France.
	Vargas & Mayorga (M.)	Spain.

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Awards in Class 20; Ceramics.

Bronze medals.

Vendrich & Sonne ..... Denmark.
Wakè (K.) ..... Japan.
Woodcok ..... France.
Yeërakou ..... Japan.
Zasche (J.) ..... Austria-Hungary.

HONORABLE MENTION.

Honorable mentions.

Akiyama-Aighi ..... Japan.
Allerton (C.) & Son ..... England.
Aoki (T.) ..... Japan.
Airaghi & Boni ..... Italy.
Artigues Frères ..... France.
Aubert (E.) ..... France.
Auta ..... Japan.
Bailey (W. & J. A.) ..... England.
Baratte ..... France.
Bates, Walker, & Co ..... England.
Bauza Francisco ..... Spain.
Bazin (Dame) ..... France.
Bellion (Dlle.) ..... France.
Blachet, Palaye, & Repellin ..... France.
Blot (J.-C.-E.) ..... France.
Boderon de Vermeron (Dame) ..... France.
Bohn (L.) ..... France.
Bompard Frères & Cie ..... France.
Boni (A.) ..... Italy.
Boulanger ..... France.
Boussard (D.) ..... France.
Brianchon aîné ..... France.
Bricon (Dlle.) ..... France.
Chambre municipale de Campo-Maïor ..... Portugal.
Champein (Veuve) ..... France.
Cifka (W.) ..... Portugal.
Coblentz ..... France.
Collectivé de Grèce (*diplôme*) ..... Greece.
Collectivité du Sénégal (*diplôme.*) ..... Senegal.
Commmission Centrale de Lisbonne ..... Portugal.
Comptoir du Gabon ..... France.
Constancia Compagnie ..... Portugal.
Corplet ..... France.
Couttet (Dame) ..... New Caledonia.
Cubertafon ..... France.
Cunha ..... France.
Decoure (A.) ..... France.
Delforges ..... France.
Detemerman ..... France.
Dollindon (Dame) ..... France.
Dubois (A.) Père & Fils ..... France.
Dupont ..... France.
Egoroff ..... Russia.
Espeuilles (Marquis d') ..... France.
Fabr. de Poterie de Ziegler ..... Switzerland.
Falb Carl ..... Austria-Hungary.

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Awards in Class 20; Ceramics.

Farina (A.) & Fils ..... Italy.
Ferreira-Pinto ..... Portugal.
Fita & Rovira (M.) ..... Spain.
Garcia de Montalban (F.) ..... Spain.
Garreta (F.) ..... Spain.
Gasparoli (Dlle. Maria) ..... Belgium.
Girard (A.) ..... France.
Giraud ..... France.
Godin Richard ..... France.
Gontran-Esnard (Dame) ..... France.
Goode (T.) & Co ..... England.
Gossart ..... France.
Gouillet ..... France.
Greber (P.) ..... France.
Gautemala ..... Gautemala.
Giustiniani (M.) ..... Italy.
Guthrie ..... Victoria.
Higouti ..... Japan.
Hope & Carter ..... England.
Johnsson (K.-E.) ..... Norway.
Kato (M.-N.) ..... Japan.
Kleniewski (J.) ..... Russia.

Honorable mentions.

Ladreyt (E.) ..... France.
Lamego (Veuve) ..... Portugal.
Lamonnierie & Bobillot ..... France.
Landry ..... France.
Leclaire (L.-L.) ..... France.
Léobardi ..... France.
Leprince (L.-A.-A.) ..... England.
Lesueur ..... France.
Lévêque ..... France.
Lordereau ..... France.
Louis (J.) ..... France.
McLaughlin (Miss L.) ..... United States.
Maltby (Dlle. E.) ..... Belgium.
Maltby (Dlle. G.) ..... Belgium.
Manufacture de Toury-Lurcy .....
Marchand (Dame) ..... French New Caledonia.
Martinique ..... France.
Matsoumoto (Y.) ..... Japan.
Mercier-Pageyral ..... France.
Meyer (E.) ..... Denmark.
Minghetti & Fils ..... Italy.
Moreau & Tristan ..... France.
Mori (Y.) ..... Japan.
Nagasaki ..... Japan.
Nugent (Dlle. de) ..... France.
Oliveira ..... Portugal.
Orilla Fils aîné ..... France.
Outi (Dlle. M.) ..... France.
Périchon (Dlle.) ..... France.
Perrignon de Frénoy (Dlle. A.) ..... Belgium.
Perrot & Mayor ..... Switzerland.
Picazo (J.) ..... Spain.
Quinter ..... France.

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Awards in Class 20; Ceramics.

Honorable mentions.

Raedler & Pilz ..... France.
Richard (Mme) ..... France.
Ruiz-Canela (J.) ..... Spain.
Rivière (O. de) ..... France.
Rollé (A.) ..... France.
Rouget (Dele) ..... France.
Rosselot ..... New Caledonia.
Saçada (K.) ..... Japan.
Sa Majesta le Roi de Siam (*diplôme*) ..... Siam.
Son Altesse Royal le Dey de Tunisie (*diplôme*) .. Tunis.
Sanchez-Cabellero-Manuel ..... Spain.
Sanchez (Antolin) ..... Spain.
Schon (P.-C.) ..... Denmark.
Schmidt Ludmilla ..... Austria-Hungary.
Schuler (H.) ..... Canada.
Sens Frères ..... Luxemburg
Simizou (R.) ..... Japan.
Simpson (W. B.) & Son ..... England.
Société des Collettes ..... France.
Souchet & Cie ..... France.
Tagakui ..... Japan.
Takàcs (V.) ..... Austria-Hungary.
Thooft ..... Netherlands.
Torquay Terra Cotta Company ..... England.
Vacas (P.) ..... Spain.
Van Immerseel (Dlle. H.) ..... Belgium.
Vaux-Bidon (Dlle. de) ..... France.
Vignon (C.) ..... France.
Vivien (E.) ..... France.
Wudia (F.) ..... Austria-Hungrry.
Yamada (M.) ..... Japan.

Awards to collaborators:

COLLABORATORS.

Gold medals.

GOLD MEDALS.

Avisse (Manufacture de Sèvres) ..... France.
Personnel (Le) de la Manufacture de Sèvres (*diplôme*) ..... France.

Silver medals

SILVER MEDALS.

Arnoux (L.) ..... England.
Halot ..... France.
Longuet (C.) ..... France.
Peyrat ..... France.
Tinworth (George) ..... England.

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GREAT BRITAIN.

Plate 2. Emblematic British Potter.

The pottery industry of Great Britain was largely represented at Paris, as will be seen from the following list, comprising the best-known establishments of Staffordshire and Worcester.

LIST OF EXHIBITORS.

List of Exhibitors.

ADAMS & BROMLEY, *manufacturers; Victoria Works, Hanley, Staffordshire.* Jasper, majolica, and engraved Rockingham ware; fountains; large lion; flower-pots; vases; jugs; bread-trays; cheese-trays; spittoons; match-stands; dessert ware; flat candlesticks; tea ware; *tête-à-tête* sets; flower-baskets; fruit-dishes; tripods; oval and square *jardinières*; garden-seats; inkstands; brackets; butters; small ornaments; egg-stands; flower-troughs.

ALLERTON, CHARLES, & SONS, *china and earthenware manufacturers; Park Works, Longton, Staffordshire.* Earthenware china, consisting of sanitary, dinner, tea, and toilet ware; luster ware.

BAILEY, W. & J. A., *earthenware and glass manufacturers; Alloa, Scotland.* Earthenware; Rockingham tea-pots, coffee-pots, and filters; cane ware; tortoise (majolica); cut, engraved, and pressed table glass; gas globes.

BATES, WALKER, & CO., *earthenware manufacturers; Dale Hill, Burslem, Staffordshire.* Dinner, dessert, toilet, tea, and breakfast ware; sanitary ware; jugs, tea-pots, and kettles; sign-boards; letters; porcelain weights; thermometer; scales; goods for druggists, perfumers, photographers, iron-mongers, stationers, etc., and for artists' use; punch-bowls; spirit barrels; garden ware; jet and terra-cotta vases, etc., variously decorated with colored dips; patent tea-pots, kettles, jugs, etc., with automatic, self-locking, self-adjusting covers; "indestructible ware," very hard and vitreous.

THE BROWNHILLS POTTERY COMPANY, *earthenware and china manufacturers, Brownhills; works, Tunstall, Staffordshire.* Dinner and dessert, tea, and toilet ware; printed, enameled, painted, and gilded vases and ornamental goods; black glazed ware; floor and roof tiles, ridge tiles, etc.

BROWN-WESTHEAD (T. C.), MOORE, & CO., *manufacturers of china and earthenware; Staffordshire Potteries and Royal Victoria Works, Hanley.* China and fine earthenware in every variety of table, dessert, tea, and toilet ware; ornamental goods in china, parian, and majolica; sanitary ware; tiles, plain and ornamental, for floors, borders, mural decorations, flower-boxes, names of streets, railway stations, etc.

THE CAMPBELL BRICK AND TILE COMPANY, *manufacturers of encaustic, geometrical, and majolica tiles, Stoke-upon-Trent.* Encaustic and geometrical tiles for pavements of public edifices and private buildings; glazed encaustic tiles for hearths and fire-places; glazed earthenware and majolica tiles for mural decorations; slabs of tiles to show their application; tesseræ, and slabs of mosaic made from same; building bricks, ridges, roofing-tiles, etc.

COPELAND, W. T., & SONS, *manufacturers of porcelain, etc., and inventors, London; works, Stoke-upon-Trent, Staffordshire.* Art productions in porcelain, ceramic statuary, etc.

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COPELAND, W. T., & SONS, *manufacturers of porcelain, etc., and decorators*, *London; works, Stoke-upon-Trent, Staffordshire.* Art productions in porcelain, ceramic statuary, etc.

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PLATE 2.

ENGLAND.
(Grafito tile by Solon.)
Emblematic British Potter.

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CRAVEN, DUNNILL, & CO., *encaustic, geometrical, and majolica tile manufacturers, Jackfield Works, near Ironbridge, Shropshire.* Encaustic and geometrical flooring tiles for churches, conservatories, vestibules, halls, corridors, etc.; majolica and glazed tiles for hearths and fire-places; dados and ornamentation of interior and exterior walls of buildings; printed and painted art tiles for furniture, grates, and pilasters; enameled tiles for walls of baths, kitchens, stables, etc.; two fire-places, completely fitted to exhibit tiles, and made by the Coalbrookdale Company.

DANIEL, A. B., & SON, *manufacturers of and designers in china, earthenware, and table-glass, London.* Table services of every description; toilet services; ornamental china, and objects of art in ceramic manufacture; majolica and earthenware; table-glass, engraved, cut, and plain.

DOULTON & CO., *potters, Lambeth, London.* Fountain in Doulton ware, in spiral form, representing twenty-two Scripture subjects, designed and executed by George Tinworth; panels in terra cotta, decorated with Doulton ware, representing Scripture subjects; heads from the antique in terra cotta, set in Doulton ware.

List of Exhibitors.

DOULTON & WATTS, *potters, Lambeth Pottery, London.*

DOULTON, HENRY, & CO., *potters, Lambeth, London; works, Smithwick and Rowley, Regis, Staffordshire,* and *St. Helens, Lancashire.* Terra cotta applied to fine art; Lambeth–*Faïence.*

EDWARDS, JOHN, *white granite manufacturer, Fenton, Staffordshire.* White granite tea, dinner, toilet, and jug services, white and ornamented.

GARDNER, JOHN, & SONS, *lamp manufacturers, London.* Earthenware; artistic blue printed table ware; filters in English wedgewood; *faïence* and *gris* (stone ware) on Major Crease's principle.

GOODE, THOMAS, & CO., *depot for Minton's china, London.* Etchings on china, by Mr. William Goode; porcelain and majolica, by Minton.

GREEN, JAMES, AND NEPHEW, *glass manufacturers and designers, London.* The terra-cotta productions of the "Torquay Terra Cotta Company."

HOPES & CARTER, *earthenware manufacturers, Burslem, Staffordshire.* Table, tea, dessert, and toilet ware, in earthenware, both decorated and plain; vases, tea pots and jugs in earthenware, decorated both in white and jet.

HOWELL, JAMES, & CO., *inventors and producers, London.* A series of clocks and other objects in the early English Queen Anne and Jacobean styles, inlaid with panels and plaques of *faïence,* etc., showing the application of ceramic art for decorative purposes; selected specimens of art pottery; a collection of original paintings on china and *faïence* by artists and amateurs.

JONES, GEORGE, & SONS, *Trent Potteries, Stoke-upon-Trent.* China, majolica, and earthenware.

LEPRINCE, LOUIS AIMÉ AUGUSTIN, *painter and designer on enamel and china, etc.; Leeds School of China Painting, Leeds.* Paintings on enamel, china ware, etc.; vases, dishes, slabs, tiles, etc., painted, enameled, and gilded in various styles; also miniatures, etc., on enamel.

MAW & CO., *manufacturers of encaustic and other tiles, Benthall Works, Broseley, Shropshire.* Encaustic tiles; geometrical, pictorial, and Roman mosaics, for pavements, hearths, etc.; enameled and glazed tiles, plain and decorated, for wall lining, fire-places, baths, etc.; hand-painted art tiles, and large slabs and plaques, for fire-place splays and inlaying in wood and stone work; architectural majolica

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GREAT BRITAIN.

for pilasters, string-courses, chimney-pieces, and fenders; a collection of tiles, tazzas, etc., in luster, being a reproduction of the mediæval art; terra cotta plant-markers, etc.

MINTON, *inventors and manufacturers of tiles and pottery; China Works, Stoke-upon-Trent and London.* Vases; ornaments; dinner, dessert, tea, breakfast, and toilet services, in white, painted, and enameled earthenware; porcelain *pâte-sur-pâte;* white and colored parian; majolica and palissy; Indian ware; *faïence d'Oiron* (Henry II); Persian ware; white, printed, enameled, and hand-painted art tiles and mosaics.

MINTON, HOLLINS, & CO., *inventors and manufacturers; Patent Tile Works, Stoke-upon-Trent.* Plain and encaustic tiles, glazed and unglazed; embossed majolica tiles; art-painted and enameled tiles; ceramic mosaic.

PINDAR, BROWNE, & CO., *earthernware manufacturers, inventors, Burslem, Staffordshire.* Vases, jars, plaques; dinner, dessert, tea, and toilet services; sanitary ware, such as table-tops with basins, plug-basins, etc.

THE ROYAL PORCELAIN WORKS COMPANY, *manufacturers and inventors (R. W. Binns, F. S. A., managing director), Worcester.* Porcelain in vases and services; ivory porcelain in vases, statuary, and services; vitreous brown ware for services; decorative objects in Japanese taste; jeweled porcelain; Worcester enamels on porcelain.

List of Exhibitors.

STIFF, JAMES, & SONS, *stone ware and terra-cotta manufacturers, London Pottery, London.* Vases, jugs, water-filters, etc., in the new decorated Lambeth ware, only once fired, etched, colored, and glazed in the unburnt clay; brown and white stone-ware bottles, jars, etc.; specially hard body and brilliant glaze, intensely vitrified.

THE TORQUAY TERRA COTTA COMPANY, *manufacturers, Hill Cross Pottery, Torquay.* Statuettes of classical, historical, and original design; vases with enamel decoration, over and under glaze; plaques painted in enamel; jugs, water-bottles, flower-pots, etc.

WATCOMBE TERRA COTTA COMPANY, *fine-art potters, Watcombe, South Devon.* Fine-art pottery in glazed and biscuit ware; statuettes, etc.

WEDGWOOD, JOSIAH, & SONS, *potters, Etruria, Stoke-upon-Trent, Staffordshire, and London.* Wedgwood's fac-simile of the original Portland vase; a cabinet, decorated with jasper plaques, illustrative of Chaucer, Shakespeare, and Milton, modeled and designed by C. Toft; jasper vases and plaques; bas-reliefs, models, and designs; a chimney-piece and paneled superstructure, decorated with plaques and vases painted under glaze on colored bodies, by T. Allen and other painters; a pair of large Greek vases, brown body, painted under glaze, painted by Allen; a pair of china Renaissance vases, subjects from Milton; two large swan vases, earthenware, painted in blue underglaze, subjects "Triumph of Flora" and "Samson"; pair of vases, subjects from the Odyssey; pair of Greek vases, painted in color underglaze, subjects "Orpheus and Eurydice"; pair of Renaissance vases, same style, nymphs and Amorini; pair of Greek vases, imitation red granite bigornian ware; an application of glass engraving to pottery; various vases and plateaus painted with flowers, figures, and landscapes, by various painters.

Minton.

MINTON, STOKE-UPON-TRENT.

The outline list of objects sent by the Mintons gives but a faint idea of the extent, richness, and beauty of the ex-

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hibit of the products of these renowned china works and of the art studios connected with them. The great variety of beautiful objects was contained chiefly in a quadrangular court, fitted with exterior and interior cases, and designed by R. Norman Shaw, R. A. Both within and without the walls of this space there was a profusion of the triumphs of the potter's and the decorator's skill, from the ordinary vase to the reproductions of the *faïence d'Oiron*, the paintings of Mussill, and the *pâte-sur-pâte* of Solon. British potters could look with pride to this exhibit as an exemplar of their art, and lovers of art everywhere could rejoice in it as the exponent of a power in art culture enshrined in enduring clay and enamel. The great progress which has been made at these works in all departments is largely due to the generous appreciation of the possibilities of the industry by the present head of the establishment, C. Minton Campbell, M. P. The Mintons received one of the three grand medals given in this class, the other two being given to French exhibitors.

Minton exhibit.

R. Norman Shaw, R. A.

Mussill. Solon.

Grand medal.

Mussill's paintings.

Mussill's paintings.

The birds and flowers, by this artist, in underglaze enamel colors, are well known to connoisseurs in the United States. Some of his best work shown at Paris was upon two enormous vases of the dark-red body with which the Minton works have achieved such success in vases, plaques, and tiles. These vases were five feet high, permitting the birds and orchid flowers to be of the size of life. For brilliancy and accuracy of coloring and of drawing these pieces could scarcely be excelled, and no description suffices to convey a conception of their beauty. A large vase of dark-green body, with pseudo-bronze trimmings in the Chinese and Japanese style, has recently been imported by the Messrs. Tiffany & Co., of New York, and is decorated by Mussill in the same style as those shown at the Exposition. Storks or herons and aquatic plants and flowers constitute the decoration. The white water-lily of full size seems to stand out in relief from the surface. All this beautiful painting is *underglaze*, being thus incorporated with the body and protected by the glassy covering, while the brilliancy and depth of coloring is enhanced.

Underglaze enamel.

Vases in Chinese and Japanese styles.

A large pair of vases in turquoise-blue, decorated by Mr. Pilsbury, also deserve special mention.

Pilsbury.

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GREAT BRITAIN.

Minton exhibit.

There was also a pair of tall vases of Pompeiian design, painted by Mr. Foster, with dancing women after Bourier, and a set of twelve desert plates on which Mr. Boullemin has painted a series of pictures copied from Joseph Vernet.

Foster.

Boullemin.

Minton vase.

FIG. 1.—*Minton vase, decorated by Mr. Pilsbury.*

The painting is executed upon the vases when in the biscuit state, and the artists are able to paint upon it with the underglaze colors with all the dash and freedom of one using water or oil colors, so that every touch of the brush remains.

Some trays in soft-paste porcelain were beautifully decorated by paintings after Teniers. There were some beautiful plates of earthenware, octagonal in form, in red and gold decoration, like the early English copies at the Worcester works after Japanese patterns. Other plates were of celadon green body, with perforated borders and gilt in panels; some in porcelain showed a contraction in baking of one-quarter of an inch more than the *faïence*.

Mixed clays—pâte-changeante.

Mixed clays.

One of the interesting features of the Mintons' manufacture is the number of colored bodies used in the art vases and pieces of decorative porcelain. Most of the porcelain vases are molded of colored bodies, often of dark olive-green, such as oxide of chrome imparts. Some very curious pieces in the exhibit were formed of a combination of these clays laid together and joined but not intermixed, so as to produce a marbled or mottled effect.

These combinations are formed by taking scraps and pieces of the bodies of different color, such as are left over in making vases and plaques. These mixtures give what is known as "scroddled" ware among the potters. "Tortoise-shell ware" had a similar origin.

Various colored slips are employed, to the number of a dozen or more, upon the elaborate vases in bands, fillets, and

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dentilated ornaments with good effect. This is really one form of *pâte-sur-pâte* decoration. GREAT BRITAIN. Minton exhibit.

Of *pâte-changeante* there were several pieces. It is a peculiar chameleon-like ware—a porcelain—which appears of one color by solar light and another color by gaslight. In the daylight it has a grayish or celadon green color, and at night it appears pink. This kind of paste was compounded by the chemist Regnault when director of the Sèvres establishment. *Pâte-changeante.*

Henri-Deux ware. *Henri-Deux.*

The Mintons' display contained several pieces of copies, reproductions of the famous Henri-Deux ware, or *faïence d'Oiron.*

"Of the original ware, there are said to be only 55 pieces known. There are 20 enumerated in the list of photographs of specimens in the collection at South Kensington, including 2 in the Louvre. Brongniart in his treatise says that about 37 were known in France.* This ware has always excited great interest among collectors and connoisseurs, based upon its intrinsic beauty and novelty and its extreme rarity. The pieces have sold for fabulous prices. An *aiguière*, or ewer, belonging to Mr. Magniac was purchased for £80 at the sale of M. Odiot's collection in 1842, and shortly after was sold for £96, and has since been valued at £2,000. A circular plateau in the South Kensington Museum, purchased originally by M. Espoulart, of Mans, for £3 4*s.*, was bought in 1857 for £140. At the sale of the collection of the Comte de Pourtalès, in March, 1865, the 'Biberon' was purchased by Mr. Malcolm for the sum of £1,100. This Biberon is one of the best-known specimens of the ware. A capital figure is given in Brongniart, pl. xxxvii. It stands a little over 10 inches in height, and bears the arms of France, with a coronet, and the initials and emblems of Diane de Poitiers. The ciphers and armorial bearings, which appear on so many specimens, indicate, beyond doubt, that this ware was the favorite at the brilliant court of Francis I, and Henry II. Its origin was for a time in doubt, and has been the subject of much speculation, but it is now conceded that it was made at Oiron, in the southwest of France. History of the *faïence d'Oiron.* Historic pieces.

"In composition it is a *faïence* of superior quality, the paste, according to an analysis by M. Salvetat, of the Sèvres laboratory, consisting of— Composition.

Silica	59
Alumina	40.24
	99.24

without lime or magnesia, and only a trace of iron. It withstands high firing without change, and is quite white. M. Salvetat was also satisfied that the glaze did not contain tin. Brongniart notes the fact that this white earthenware body was made in France long before the first attempts to manufacture white earthenware in Great Britain, which dates from the end of the seventeenth or the beginning of the eight-

*"At that time the most interesting specimens were in the possession of M. Saurageot, M. Odiot, M. Preaux, and M. Count Portalès. The Ceramic Museum at Sèvres had only two."

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GREAT BRITAIN. Minton exhibit.

eenth century. But the distinguishing peculiarity of the Henri-Deux ware remains to be described. The ornamentation is inlaid, filling incisions or depressions in the body, though flush with the surface. For this filling pastes colored with ocher were chiefly used, and the designs in general appear of an ochery brown or yellowish color on the white groundwork. But black, blue, pink, and green colors are known. It is believed that this inlaying was accomplished by means of molds, the intricate interlacing designs being first carved upon a model, from which casts were taken. The paste, pressed in the molds so formed, received the designs in intaglio, and the spaces were afterwards filled with a soft, colored paste, the whole operation being similar to that of making encaustic tiles."

Henri-Deux process.

Minton's *Henri-Deux*.

FIG. 2.—*Mintons' "Henri-Deux" ware.*

Fine examples of this ware were also shown by this firm at Vienna in 1873.

Etching in porcelain.

Etching on porcelain.

W. Goode.

In the collection of Mintons' porcelain shown by Mr. W. Goode there are some curious etchings upon the glazed surface of porcelain vases, executed by Mr. W. Goode as an amateur. The process consists in first covering the surface with a black varnish, through which the design is drawn with a sharp steel point down to the glaze. By the application of fluoric acid the glaze is dissolved away and a fine depressed line results. The varnish is then removed and some strong color or gold is rubbed into the depressed lines, and the piece is ready for refiring in a kiln, by which the glaze is softened and the color or gold is covered and securely held. Mr. Goode has made several pieces for his amusement and has presented examples to the museums of St. Petersburg, Vienna, Berlin, and South Kensington.

Process.

Pâte-sur-pâte.

*Pâte-sur-pâte.**

Solon.

Solon's work in paste cannot be described. Mintons' court was enriched with a profusion of examples, and all of

* The nature of this process is fairly indicated by the name. It is literally paste-upon-paste. It is by no means a new process, being one long known and used in China for decoration of porcelain and in India for common ware. It was first introduced in Europe at Sèvres in 1847, under Ebelman. The process consists in taking a thin mixture of the

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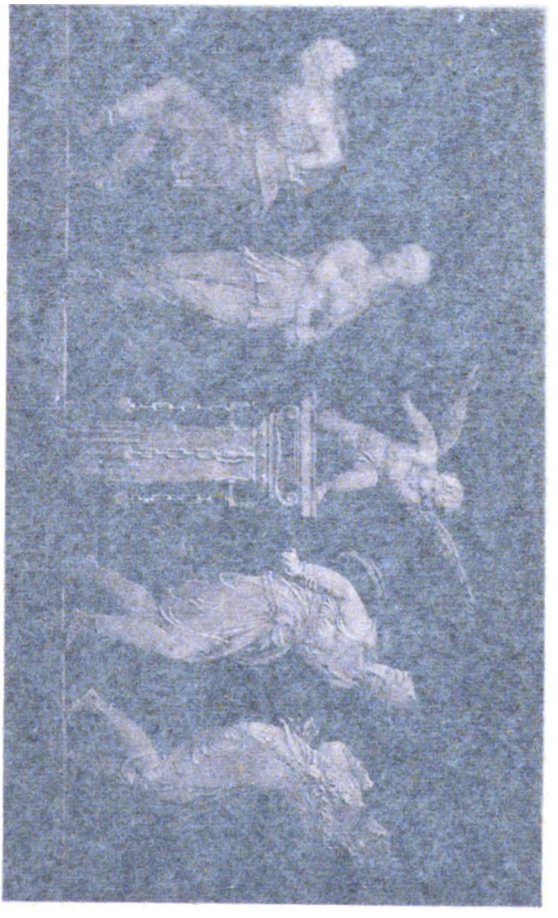

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under Ebelman. The process consists in taking a thin mixture of the

HELIOTYPE PRINTING CO., BOSTON.

CUPID DRIVING.

Pâte-sur-pâte plaque, by **SOLON.**

[Plate 3.]

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HELIOTYPE PRINTING CO., BOSTON.

CUPID CHAINED.

Pâte-sur-pâte plaque, by SOLON.

[Plate 4]

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reproduced mechanically than can a Madonna of Raphael.

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the highest degree of merit, on vases, plaques, and plates. There was no sign of wearying in well-doing by this master-artist in clay. His work is incomparably superior to that of any of his imitators, far surpassing in art value the best examples of figure-subjects from the kilns of Sèvres. He alone fully and satisfactorily unites skill in the technique of the paste and glaze and the genius of sculptor and designer. His favorite subjects, as is well known, are the female form, Cupids, and cherubs. He delights in illustrating the pranks Cupid plays with the hearts of maidens. A few illustrations from photographs of some of the pieces are presented. Upon one of the plaques, with a dark-green background of porcelain forming the body of the plaque, Cupid is seen modeled in white paste, standing on the capital of a column, driving a team of four maidens by silken cords attached to their wrists. The attitude of Cupid with his outspread wings and the more than half-willing thraldom of the maidens command our admiration.

GREAT BRITAIN. Minton exhibit. Solon's *pâte-sur-pâte.* Plate 3. "Cupid driving."

In the companion piece, a plaque of equal size, four maidens are chaining Cupid to a block. Plate 4. "Cupid chained."

The flat sides of pilgrim bottles for decorative purposes are suitable to this class of work. They are made either of dark green or red porcelain. On one pair Cupid is seen seated by the side of a basket, with a needle in one hand and a heart in the other, looking intently at the heart as if he recognized it and hesitated before putting it on the string of hearts at his side. The companion bottle shows Cupid—here a half-grown youth—seated with a basket of hearts between his knees, while he picks them out one by one and tosses them over his shoulder. Plate 5. Pilgrim Bottle.

On another long plaque we have Cupids at supper, four of them seated on tall stools at table, with a central female Plate 1. Frontispiece. "Cupids at supper."

porcelain paste and laying it on the plaque or vase as a painter lays on colors, except that the design is to be in relief and the lights and shades are to be due in part to the greater or less thickness of the paste laid on. The paste is usually white, while the body or ground work is darker in color, usually a dark olive-green, a brown turquoise blue, or a black. After laying on a sufficient thickness for the figures of the design the artist scrapes or works away portions of it until the proper thickness and form are secured. The translucency of the fired paste permits the dark background to "show through" more or less in the thin places, while the thicker portions stand out whiter and appear in high relief, like the white figures of an onyx cameo. By firing, the translucency of the design is heightened, and the glaze sinking into it and uniting it with the body forms the whole into one homogeneous mass, with an etherial liquidity which is both subtle and delicious. It is not a process of molding, but of sculpturing, and can no more be reproduced mechanically than can a Madonna of Raphael. *Pâte-sur-pâte* process.

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GREAT BRITAIN.

Minton exhibit.

figure holding a baby Cupid and feeding him with pap from a spoon. Another little fellow on the floor has his head in the bowl. (See Plate 1, frontispiece to this report.)

Amorini vase.

Solon.

In the Amorini vases, style of Louis XVI, thirty-eight inches high, an illustration of which is annexed, the body is a celadon-green, with a zone or belt in the upper portion of a fine blue color, on which Solon has worked a number of Cupids, who are busily engaged in breaking chains of iron, and other Cupids are rejoicing over roses that take their places. These vases are richly gilt, and for supporters have each a group of Cupids or *Amorini*, finely modeled in oxydized silver.

FIG. 3.—*Amorini vase, Minton.*

Small objects in *pâte-sur-pâte.*

There are many smaller works in *pâte-sur-pâte*, such as table-plates, paper-weights, and trays. In one of the trays a girl is represented jumping over a rope held by Cupids. In this the pastes used have been slightly tinted, as also in some of the plates and smaller plaques, the hair, and sandal-strings, and portions of the drapery are laid on in colored paste.

Model of the Etruscan vase in Naples museum.

"Cupid lecturing."

But the chief work of Mr. Solon is the large vase in Etruscan form, 31 inches high, and modeled for the Mintons' works, from the original in the Naples Museum. Having a full, oviform body, it gave ample surface for the beautiful bas-relief Solon has modeled upon it. The subject is Cupid lecturing. But Cupid is here not a chubby child, but a beautiful youth. He stands on a tribune in the center, while disposed about him as an audience are groups of maidens, some fifteen or twenty in all, in various attitudes. The modeling of the figures, in every detail of form, expression, and drapery, is masterly and the perspective is remarkable. This piece deserves to be ranked as a *chef-d'œuvre.*

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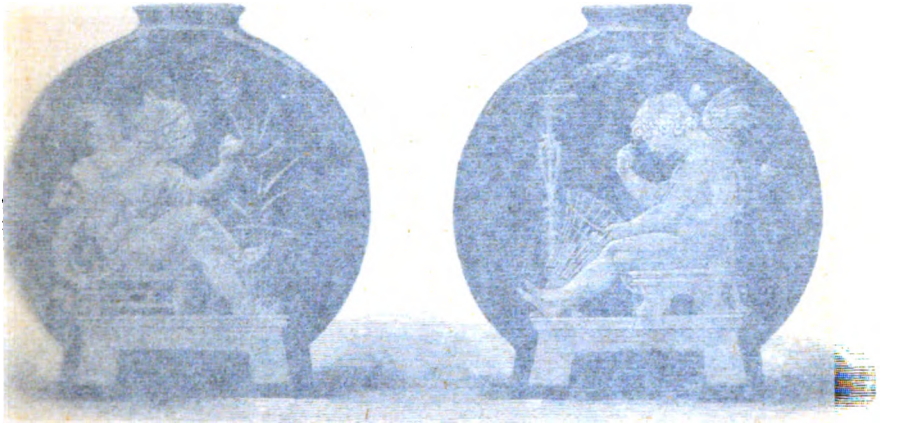

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remarkable. This piece deserves to be ranked as a ... *d'œuvre.*

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PILGRIM BOTTLES.
Pâte-sur-pâte by Solon.

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THE ROYAL PORCELAIN WORKS, WORCESTER. GREAT BRITAIN.

Royal Porcelain Works, Worcester. R. W. Binns, F. S. A. E. P. Evans.

These works, with Mr. R. W. Binns, F. S. A., managing director, and E. P. Evans, manager and secretary, made a most attractive and instructive display of the specialties of the works, notably of vases of ivory-porcelain and colored gold, illustrating the manufacture of procelain in Europe in the sixteenth century; dessert services in the old Worcester and in the spirit of Japanese designs; specimens of pressed china and of variously decorated vases and services of china, painted, enameled, and gilded.

The interior of their most attractive court was filled with choice productions, especially the two large flagons with recessed sides in panel, holding figures in relief illustrating the work of the potter and decorator. All the products exhibited gave most satisfactory evidence of progression and improvement since the exhibition in Vienna in 1873, and at Philadelphia in 1876.

History of the manufactory.

The manufacture of fine porcelain was commenced at Worcester in the year 1751, and the first royal patent was given in 1789. The undertaking originated chiefly through the exertions of Dr. J. Wall, a physician with chemical skill and artistic tastes. As early as the year 1763 the productions of the establishment were highly esteemed. Dr. Wall, at an early date, applied the process of transferring printed designs to a glazed surface to the decoration of his porcelain. The earliest known date of this printed ware is 1757, upon a jug now in the collection of the Museum of Practical Geology, London. The design is in black, *over* the glaze, and the pieces so decorated were exposed to the heat of the enamel kiln only. The invention of underglaze printing soon followed, the designs being transfered to the unglazed biscuit. Robert Hancock, who had studied under Ravenet at the enamel works at Battersea in 1750, was the engraver of the early designs for transfer.

Dr. J. Wall.

Printed designs on porcelain.

Underglaze printing.

Robert Hancock.

Composition of Worcester porcelain.

The earliest Worcester porcelain, according to Mr. Binns,* was made of a frit body, and he thinks that the following formula is similar to that used by Dr. Wall: Sand, 120 parts; gypsum, 7; soda, 7; alum, 7; salt, 14; and niter, 40. After fritting, it was crushed, and 75 parts were mixed with 15 of whiting and 10 of pipe-clay. The glaze used contained 38 per cent. of red lead, 27 of sand, 11 of ground flints, 15 of potash, and 9 of carbonate of soda. For com-

* "A Century of Potting in the City of Worcester, being the History of the Royal Porcelain Works from 1751 to 1851," by R. W. Binns, F. S. A., 1865, p. 40. Also, in De La Beche, "British Pottery and Porcelain."

R. W. Binns, F. S. A., "Century of Pottery." De La Beche.

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GREAT BRITAIN.

Royal Porcelain Works, Worcester.

mon ware an inferior paste was made, containing steatite. This gave a body less dense than the other, and of a yellowish color.

Attention was early given to the imitation of Chinese and Japanese wares, induced by the high estimate in which Oriental porcelain, or china, was then held. And with that depraved pandering to public prejudice which seems to be one of the great vices of the ceramic art, false marks were sometimes affixed, especially to these early imitations.

Trade marks.

A crescent is one of the earliest ordinary marks, as, also, a script *W.*, and afterwards the name or initials of the firm, either stamped in or printed. A Chinese fretted square, marked in blue, was frequently employed. Oriental characters were also marked in blue on some of the pieces, and a specimen in the Geological Museum has the Dresden mark of two crossed swords in blue under the glaze.

Lord Dudley's tea set.

At the Vienna Exposition in 1873 specimens were shown of the beautiful tea-set presented to Lord Dudley on his

Turquoise enamel.

marriage. The decoration consists of turquoise blue enamel, put on in drops near together, so that the surface appears to be thickly set with turquoise. Each cup and saucer is carefully mounted in a stuffed morocco case. The small set of 6 pieces was valued at $6,000.

Ivory-tint porcelain.

The softness of tone of the delicate cream or ivory tint porcelain of this establishment is well known. Its resem-

Depolishing.

blance to ivory is greatly increased by a process of depolishing which has lately been adopted. This removes all the vitreous appearance from the surface, and leaves it with the peculiar dull luster of the ordinary surface of ivory. Some statuettes treated in this way looked like ivory carvings. Gold-work ornaments show with greater effect on this surface. This ivory paste is generally supposed to contain phosphate of lime in the form of bone-dust, but I am assured that it does not. Bone porcelain is whiter. The ivory paste evidently molds well, suture lines being visible on many of the pieces. It partakes of the nature of soft paste, but it is not the same.

Japanese style.

The Japanesque style, or "*motif*," prevails throughout the decorative products of the Worcester works. We note particularly a black paste or background on which landscapes are painted in the distance; and in the foreground Japanese designs, such as branches of trees, peach blossoms, butterflies, and birds, are boldly drawn. The black of the background is intense, and sets off to great advantage the blue and other colors used in decoration.

There were some examples of inlaying white paste in the

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GREAT BRITAIN.

dark-colored body, much in the same way as the *Henri-Deux* ware is made.

Royal Porcelain Works, Worcester.

Some vases in the collection were molded of two clays in a peculiar way, the designs in relief being first worked into the depressed parts of the mold by a brush with colored clays, as, for example, such decorative objects as leaves, flowers, and arabesque patterns, and then the body-clay being cast upon and uniting with them, forming one homogeneous mass, but with the designs of one color and the body of another color.

Molding in two colors.

Open-work or pierced porcelain.

The examples of open-work or pierced porcelain were particularly good. In some of this class of work the openings, after baking, were filled with vitreous glazes, or enamels, and then rebaked, so that the enamels, in fusing, filled the spaces with a semi-transparent glass, producing a beautiful effect on holding the piece between the eye and the light. This ware will be recognized as similar to the "rice-porcelain" of China. Another form of the process is the execution of a design in the body, which becomes so completely filled in the glazing that it is invisible from the outside, and is seen only when looking through the side in a strong light.

Chinese rice-porcelain.

Old Worcester patterns.

The old patterns and designs of the Worcester works are extensively reproduced. One of the table services on exhibition was made in molds that are now over 100 years old. It is decorated with beautiful paintings and gold ornaments in relief. It is marked with the modern Worcester mark. The old Worcester ware is extensively imitated, and collectors should always be on their guard.

Novelties in painting and glazing.

Some beautiful results are obtained by painting peacocks under glaze and adding gilding above. The colors are brought out admirably. The establishment has brought forward some novelties in glazes and in colors and in the application of gold in several colors. Ten plaques were shown, illustrating the colors and the application of new "marble" glazes. A tablet of under-glaze colors showed the range of colors and shades in use at the works. The carmine-red is particularly bright. As an example of the use of gold in decoration, a dish or plaque, ornamented with marine shells in relief, and engraved, was particularly good. The gold was massive and thick, and in several different shades of color.

Limoges style enamels.

Thomas Botts.

Specimens were shown of enameling in the Limoges style, on porcelain, by the late Thos. Botts, and of the successful production of artificial aventurine—gold-stone—decoration on *faïence.*

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GREAT BRITAIN.

WEDGWOOD, STOKE-UPON-TRENT.

Wedgwood. The prestige of this renowned establishment at Etruria is not likely to wane. The proprietors have caught the spirit of progress, and evidently intend to be in the front rank as producers of novelties and of art pottery. The exhibit was highly creditable. As would be expected, the

Relief plaques. relief plaques in Wedgwood style were numerous, some of them cast in the old molds and others from new. Among the latter was a plaque, 9′ 6″ wide by 24′ broad, of a pale olive-green color, on which were modeled in white paste the figures symbolizing the seven ages of man, after Walter

Walter Crane. G. Toft. Crane, by G. Toft (No. 81). This was sold early, at 11 guineas.

Black basalt. Black basalt and jasper ware was shown in great variety.

White jasper. A pair of vases in black basalt and white jasper ware, standing with the pedestals about 2′ high, and the subject of the decoration the apotheosis of Homer, were sold at £70.

Copy of the Pegasus vase. There was a fine copy of the Pegasus vase, being a reproduction from the original molds of the vase designed and modeled by Flaxman, of which there are only two in existence—one in the possession of Sir Dudley Coutts Marjoribanks, and the other being lately sold by Messrs. Christie, at auction, for 700 guineas, from the celebrated collection of Dr. Gibson.

Many of the plaques were decorated with new designs, by G. Toft.

Pâte-sur-pâte. The firm has also given attention to the production of porcelain vases in variously-colored bodies, with *pâte-sur-*

Rhead. *pâte* decoration, chiefly by Rhead. For one pair of vases he has chosen Egyptian subjects. The modeling is fair, but rather stiff and rigid in effect, looking as if molded rather than laid on with a free hand. The paste and glazing are excellent. Eleven different colors of paste and slip could be counted on these vases. Another vase with a dark olive-green body, at least on the surface, is decorated in *pâte-sur-pâte*, by the same artist; subject, Mercury bringing

Grafito. Pandora to earth. There was also some *grafito* work.

Table and toilet ware. Ordinary pottery for table and toilet use is made in great variety by the Wedgwoods. Some of the toilet sets in monotints were very attractive. They also exhibited a complete dinner and tea service in the celebrated cream-colored Queen Charlotte ware, commonly known as queensware.

T. C. Brown-Westhead. *T. C. BROWN-WESTHEAD, HANLEY.*

In the collection shown by this enterprising firm there were many interesting objects, especially the new colored

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stone-ware bodies—the cream-colored of Welsh clay, the lavender, and the celadon. Many of these were shown in dinner and toilet sets of new design. Among other striking objects a group of tigers, modeled or molded in one piece of earthenware, attracted attention. The group was executed by Mr. Marshall, from life, at the Zoological Gardens. The oval base is about 5′ 6″ long. The firm also exhibited candelabra in Palissy ware 9 feet high, and a series of rabbits in earthenware in a variety of comical attitudes, as modeled by Leonce, who keeps rabbits for the purpose of studying their movements and positions. There are also some large plaques, painted by the same artist, representing tropical plants, palms, and paroquets, in brilliant coloring.

T. C. Brown-Westhead's exhibit.

Group of tigers.

Palissy ware.

Leonce.

DOULTON, LONDON.

To the Messrs. Doulton we owe the revival of art pottery in the ordinary clay body and salt glaze of stone-ware, the same in substance as the body and glaze of the common gray pots in daily household use. The possibilities of art in clay have found in Doulton, in our time, their great exemplifier. The objects so made not only have beauty of form and decoration, but they are remarkably strong and durable. No duplicates are made; each piece has an individuality and a character of its own. Molds are not used. The potter "throws" and fashions the clay, as of old, upon the wheel, and the clay, while still green and unbaked, passes into the hands of the decorator, who cuts, carves, and incises the designs. Small ornaments in body of another color are also added in lines or bands. Some colored slips are used, and a few metallic oxides contribute to the richness of coloring which the final glazing in the open salt-glaze kiln imparts. The high heat and the unequal distribution of the oxydizing flames give varied and unexpected effects upon the coloring, which is generally extremely rich in tone, the dark browns, grays, and olive-greens predominating. In all this work the Doultons have been ably aided by a corps of artists, who may be said to have been educated at the works or in the adjoining Lambeth art school. It was at this school that the genius of Tinworth was first recognized and encouraged, with what result the admirers of his masterly works over Europe and America can appreciate. From a poor boy, hanging about the vestibule of the art school he so longed to be permitted to enter, he now stands foremost in the corps of Lambeth artists, and sends out the little terra cotta relief panels of Scriptural scenes,

Doulton's exhibit.

Character of the ware.

Objects thrown, not molded.

Ornamented by carving and colored slips.

Varied colors produced in the kiln.

Tinworth.

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GREAT BRITAIN.

which command the admiration of such artists as Doré and Meissonnier.

Doulton's exhibit.

Visitors at the Centennial Exhibition will remember the pulpit in terra cotta and the baptismal font in Doulton's display, both of which were adorned with Tinworth's terra-cotta carvings. These and the two large panels, 5′ by 3′ in terra cotta, illustrating scenes in the Garden of Gethsemane, are now in the ceramic hall of the National Museum at Washington. At the Paris Exposition one of Tinworth's chief works was the fountain in the court of the Pavilion of the Prince of Wales, on which he lavished his skill in modeling the various scenes described in the Bible in which water is mentioned, such as Rebecca at the well, Moses in the rushes, and the conversion of water into wine. This artist was at that time engaged upon the *reredos* for the cathedral at York. His work upon the vases and stone-ware columns and architectural details is well known for its boldness and freedom of outline.

Objects now in Washington National Museum.

Tinworth's fountain.

Misses Barlow.

The art work of the Misses Barlow is also well known, and has contributed largely to the success of the Doulton ware. Miss Hannah Barlow, like Rosa Bonheur, excels in drawing animals. But Miss Barlow uses a sharp steel point and boldly incises the line in the soft clay on the sides of vases and on panels. Some remarkable specimens of her work were to be seen on Doulton's stand, particularly on a large pair of vases flanking the entrance. On these Miss Barlow had drawn groups of tigers from studies made from life at the Zoological Gardens. The effect of these drawings, especially on smaller objects, such as jugs, flagons, etc., is heightened by a preliminary coating of light-colored slip overlaying the stone-ware body. The incised lines cut through this lighter-colored coat to the darker ground underneath it.

Animal groups from the life.

Incised lines through overlaid slip.

FIG. 4.—*Doulton-ware jug.*

Doulton jug.

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Another novelty in Doulton ware is the application of a light-colored slip or body with a brush to the surface of the ware, by which any desired design is formed on the surface, being a true *pâte-sur-pâte* process. The examples were numerous and satisfactory. Doulton's exhibit. *Pâte-sur-pâte.*

The Doultons also manufacture a soft earthenware body with a frit glaze, known as Doulton *faïence*. This is decorated at the works under glaze, in somber tints, and also in bright colors, plants and flowers being the prevailing subjects. Blackberry blossoms on a dark blue background upon a large circular plaque were an especially pleasing subject. Faïence.

HOWELL, JAMES, & CO., LONDON. Howell, James, & Co.

This firm exhibited not only a collection of decorated pottery; they had in addition a series of clocks and other objects, in the early-English, Queen Anne, and Jacobean styles, inlaid with panels and plaques of *faïence*, etc., showing the application of ceramic art for decorative purposes, selected specimens of art pottery and a collection of original paintings on china and *faïence* by artists and amateurs. Clock cases.

These objects were grouped in a tastefully designed and convenient court, and were much admired. The clocks, especially, with their quaintly decorated tile faces and plaques in blue and white, were very attractive, especially to those who in building and furnishing are reverting to the styles in vogue in the days of Queen Anne. Clock faces and plaques.

These clocks are made to harmonize with early English and Queen Anne architecture, and to suit drawing or dining rooms or the library or hall. The wood-work of the cases is of ebonized cherry, or of oak or other wood. The chief parts of the cases are turned and beaded or incised, and are inlaid with silver, brass, or art-pottery panels; the latter of small white tiles decorated in blue, by hand, from original designs. The dials are also formed of tile similarly decorated, and perforated in the center for the spindle carrying the clock hands. Queen Anne clocks.

The clocks, of which illustrations are given, are from designs by Mr. Lewis F. Day and Mr. R. Phene Spiers, F. R. A., etc. They are executed in oak and walnut wood, and are inlaid with panels of blue and white china. The Queen Anne clock, design No. XIV of Howell & James's catalogue, has turned corner posts, and is 18½″ high, and 10½″ wide, and 7″ deep. Figure 5, with square posts, beaded, is 16½″ by 10½″ by 6½″. It has a blue and white china dial and four corner plaques—"The Seasons."

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GREAT BRITAIN.

Howell, James & Co.

Clocks.

The early-English clock, Figure 6, has pierced brass

FIG. 5.—*Queen Anne clock.*

FIG. 6.—*Early-English clock.*

corner plates around the dial and has three plaques emblematic of "the elements." It is 17″ high, 10½″ wide, and 7″ deep.

Clock and wall-bracket.

Another peculiar and pleasing form is a combined clock and wall-bracket, designed for the reception of specimens of art pottery. Design No. X, here reproduced, is 36″ long, 10½″ inches wide, and 5″ deep. All of these designs are registered by Messrs. Howell & James, who are the originators and sole manufacturers in England. Their superiority over the ordinary tawdry clock-cases of the cheap clocks of the United States will be appreciated. If similar designs should be introduced in the United States by our manufacturers, a great demand would arise for hand-painted dials and plaques, and many artists and amateurs could be profitably employed in designing and executing them.

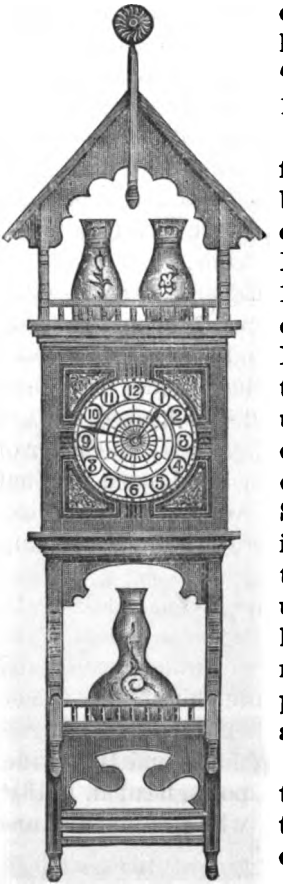

FIG. 7.—*Hanging wall-clock to hold art pottery.*

One of the first orders received at the Exposition for one of these artistic clocks was given by a citizen of the United States.

Messrs. Howell & James have instituted a series of annual compet-

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itive exhibitions, designed especially for the benefit of ladies who paint upon china, tiles, and plaques. The objects so decorated are displayed by the firm in a commodious gallery, and many of them are sold. The exhibition in 1878 contained upwards of 1,000 original works, and in two months was visited by nearly 10,000 persons. Prize medals, money prizes, and honorary diplomas are given upon the judgment of members of the Royal Academy. The names of the amateurs who carried off the prizes in 1878 are: For best amateur work, the Countess of Warwick, "Portrait of Lady Eva Greville," the gold medal presented by Her Imperial and Royal Highness the Crown Princess of Germany. First prizes: Subject, "The Angler Caught," Mr. E. Langstaffe; ornament, Miss C. H. Lee. Second prizes: Ornament, Miss C. M. Shepherd; landscape, "The Region of the Reapers," Lady Augusta Cadogan. Third prizes: Heads, "Portrait of Miss Gertrude Willoughby," Lady Willoughby; ornament, "Tomtits and Blackthorn," Miss Everett Green. An extra prize was given to Mrs. Nesbitt for "Golden Eagle," a replica having been commissioned by Her Majesty. The special prize of 10 guineas was given to Miss Ada Hanbury, for her "Fruit and Blossom of the Horse Chestnut and Lebanon Cedar Cones," as best professional work, and the special prize of 5 guineas for second-best amateur work to Miss Edith S. Hall, for her rose design.

Howell, James, & Co. Competing exhibitions.

Amateurs.

Medalists and prize winners.

Among other objects to be noted, we mention fire-screens decorated with painted tiles. One of them contained nine 6′ tiles framed in. One screen, in four folds, was ornamented with four tiles emblematic of the four seasons, and was sold to the Countess of Warwick, Warwick Castle. Small boxes for mantel-decoration were made of ebonized wood and enriched with small hand-painted tiles inserted in the sides. Some plain terra-cotta plaques were decorated by the use of "white flux," burned in, giving the effect of enamels. A painting by Mrs. Sparkes on a dead, unpolished surface, had all the effect of a fine water-color painting.

Tile-decorated fire-screens.

INDIA.

The extensive display of the art products and manufactures of India was, thanks to His Royal Highness the Prince of Wales, one of the most interesting and striking features of the Exposition. The whole of the magnificent collection made by the Prince during his travels in India was placed on exhibition. The Indian Commission also sent on a very large collection, and gathered together the finest display of Indian pottery ever made at an exhibition.

Prince of Wales' Indian exhibit.

Indian Commission.

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INDIA.

Prince of Wales' Indian exhibit.

This pottery collection filled five rectangular table cases, each about 8′ long and 4′ 6″ feet wide. There were two cases filled with tiles and plaques, and one with black pottery inlaid with silver or white metal.

Pottery objects exhibited.

The objects comprised pots, water-jugs, basins, vases, flower-pots, etc., in white and blue, in yellow ware, and in ware with a green glaze or enamel. The yellow-colored ware was decorated with a lighter colored slip, forming a true *pâte-sur-pâte* on a darker or sometimes chocolate colored ground, the designs being chiefly floral in character. The green ware is decorated also with a lighter-colored paste. The tone or tint of the whole is given by the glaze—an amber-yellow—from the soft lead glaze. The green is no doubt obtained from copper oxide.

Pâte-sur-pâte.

White-and-blue.

The white-and-blue ware seems to be a salt glaze. It is not so soft and flowing as the lead glaze and is like the Moorish ware. The body is a soft earthy red-clay mixture; a rough, coarse, red brick-clay body, porous, varying a little in color, but generally a dark-brick red or chocolate-brown. In some of the beautiful green glazed pots unglazed parts can be seen where the design is in pure white slip, and has not been reached and modified in its tone of color by the glaze. In the white-and-blue ware it is evident that there is a preliminary covering of white slip over the whole surface. The blue decoration is then painted upon this. There are two or three shades of blue. In working on the decorations some of the fewer details are added with a sharp point, as, for instance, the venation of leaves and some parts of the outline, after the broad surface of paste has been laid on by the brush.

Tiles.

In the tiles the preliminary white coat is laid on tolerably thick like an enamel. Where it is flaked off in some places it shows nearly one-sixteenth of an inch thick. It may be a stanniferous enamel. In the case of tiles there were portions of buildings, such as cornices, finials, columns, perforated balustrades, and large slabs, with inscriptions in Arabic and Sanscrit.

Without attempting to add to these notes, I present an extract from the *brochure* by Dr. Birdwood upon the pottery and arts of India.

Hand-book by Dr. Birdwood.

From the "Hand-book to the British Indian Section," by George C. M. Birdwood, C. S. I., M. D. Edin.

"POTTERY.

"Purest in art, in directness and simplicity of form and decoration, of all its homely arts is the pottery of India, the Hindu pottery of Madura and the Indian pottery of the Punjab and Scinde. Unfortunately,

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INDIA.

there is nothing of these two styles to show. Pottery is made everywhere in India, and has been from before the age of Menu. The red earthenware pottery of Travancore and Hyderabad is well known, and the red glazed pottery of Dinapur, which is glazed with a sort of varnish made of *morinda* bark, ducks' eggs, and quicklime, and the imitation of Bidiri of Surat. But all these varieties of fancy pottery, as distinguished from the primitive water-vessels thrown everywhere, are of an insignificant and almost meretricious character; and only the pottery of Madura and the Punjab and Scinde can be classed as art pottery, and as such it is of the highest excellence. The Madura pottery is in the form generally of water-bottles, with a globular bowl and long upright neck; the bowl being generally pierced so as to circulate the air round an inner porous bowl. The outer bowl and neck are rudely fretted all over by notches in the clay, and are glazed either dark green or a rich golden brown. The Scinde and Punjab pottery is egg-shaped, turbaned, melon, and onion shaped, in the latter the point rising and widening out gracefully into the neck of the vase. They are glazed in turquoise, of the most perfect transparency, or in a rich dark purple, or dark green, or golden brown. Sometimes they are diapered all over by the *pâte-sur-pâte* method, with a conventional flower, the *seventi* or lotus, of a lighter color than the ground. Generally they are ornamented with the universal cone and flower pattern, in compartments formed all round the bowl, by spaces alternately left uncolored, and glazed in color. Sometimes a wreath of the knop and flower pattern is simply painted round the bowl on a white ground. Every endeavor was made to represent this pottery at the Paris Exhibition, with the view of bringing it into European demand, but the Bombay Government, which was intrusted with the commission, has sent instead an overwhelming collection of the pottery of the Bombay School of Arts, which began with a laudable endeavor to naturalize the manufacture of Scinde pottery in Bombay, but has ended, it would seem, by getting the natives all over Western India to imitate the hardware jugs of Messrs. Doulton.

Hand-book by Dr. Birdwood.

Pottery universal in India.

Pottery of Madura, the Punjab, and Scinde rank as art productions.

Characteristics of the Madura;

of the Scinde and Punjab pottery.

Pâte-sur-pâte.

Ornamentation.

Bombay School of Arts.

"The Bombay School of Art has been singularly fortunate in the gentlemen who have directed its operations. Mr. Terry has a quick sympathy with native art, Mr. Kipling is an artist of the highest accomplishment, and Mr. Griffiths a painter of decided genius, whose works have been seen at successive Royal Academy exhibitions. It is therefore hard to explain why these gentlemen should have relaxed from their first purpose in introducing the manufacture of Scinde pottery into Bombay. Of course there is little harm done if their new ware is not passed off for Scinde and Punjab pottery. It will be very interesting if they succeed in establishing a new manufacture of a specific local character. To some of it, in which the designs are adapted from the Ajunta cave paintings and Sawuntwari playing cards, they have succeeded in giving a marked local character, and it is interesting to see Hindu mythological subjects drawn in the native style by practiced English draughtsmen. But the imitations of Doulton ware, in spite of the masterly drawing of the flower and leaf decorations, are miserable failures. It is quite a misapplication of Doulton's methods to apply them to friable Indian earthenware. The shapes also of the Bombay School of Art pottery are detestable, taken neither from Scinde nor Western India, but from Chinese sugar jars, Japanese flower vases, and English jam and pickle pots. After all, it shows worst in its imitation of Scinde pottery, from its falling so far below its originals; and this

Original purpose of the school relaxed.

Adoption of native designs approved.

Imitations of Doulton condemned.

Shapes of the Bombay School detestable.

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INDIA.

Hand-book by Dr. Birdwood.

Scindian method.

Seats of manufacture.

Drury Fortnum on the pottery of Scinde.

Analogous to the ancient Egyptian, etc.

Scindian tiles.

Colors and harmonies.

Turquoise-blue jars.

Tiled mosques.

The error of darkening the light of tradition by English teaching;

and of slavish copying by European workmen of Oriental methods and styles.

is perhaps why the effort was not persevered in. But the causes of failure are clear. The shapes of the pots are not Scindian, the glaze is used too thickly, and the patterns are applied in stencil, which gives them a thin, stiff, poverty-stricken character. In Scinde the pattern is pricked out on paper, and drawn by laying the paper on the surface of the jar and dusting it along the prickings. This gives a sufficient outline of the design to enable the decorator to paint it on with the greatest freedom and dash, *pâte-sur-pâte*, and the effect is rich, free, and harmonious beyond belief, in articles which sell for fourpence, sixpence, and one shilling each on the spot. These can fortunately never be undersold. The chief seats of the manufacture are at Lahore and Multan, Hyderabad in Scinde, Hala, Karachi, and Tatta, and for encaustic tiles at Saidpur and Bulri.* Mr. Drury Fortnum, in his report on the pottery at the International Exhibition of 1871, observes of the Scinde pottery: 'The turquoise blue painted on a paste beneath a glaze, which might have been unearthed in Egypt or Phœnicia—a small bottle painted in blue or white—is of the same blood and bone as the ancient wares of Thebes. * * * But the tiles are very important. * * * They are in general character similar to although not so carefully made as the Oriental tiles known as Persian, which adorn the old mosques of Egypt, Syria, Turkey, and Persia. * * * The colors used upon them are rich copper-green, a golden brown, and dark and turquoise blue. * * * The antiquary, the artist, and the manufacturer will do well to study these wares. As in their silk and woolen fabrics, their metal work, and other manufactures, an inherent feeling for and a power of producing harmony in the distribution of color and in surface decoration exists among the Orientals, which we should study to imitate, if not to copy. It is not for Europeans to establish schools of art, in a country the productions of whose remote districts are a school of art in themselves far more capable of teaching than of being taught.' It is a rare pleasure to the eye to see in the polished corner of a native room one of these large turquoise-blue sweetmeat jars on a fine Kirman rug of minium red ground, splashed with dark blue and yellow. But the sight of wonder is, when traveling over the plains of Persia or India, suddenly to come upon an encaustic tiled mosque. It is colored all over in yellow, green, and blue, and other hues; and as a distant view of it is caught at sunrise, its stately domes and glittering minarets seem made of purest gold, like glass, enameled in azure and green, a fairy-like apparition of inexpressible grace and the most enchanting splendor.

"But if it is a terrible error to darken by the force and teaching of English schools of art, and the competition of government jails, and other state institutions in India, the light of tradition by which the native artists work in gold and silver and jewelry, in textiles, and pottery, it is equally an abuse of the lessons to be taught by such an exhibition of the manual arts of India as the collection of the prince's presents afford, for the manufacturers of Paris and Lyons, and Birmingham and Manchester, and Vienna to set to work to copy or imitate them. Of late years the shop windows of Regent street and Oxford street have been filled with electrotype reproductions of Burmese, Cashmere, Lucknow, Cutch, and Madras silver and gold work, along with

* "The master potters known to me by name are Jumu, son of Osman the Potter, Karachi; Mahommed Azim, the Pathan, Karachi; Messrs. Nur, Mahommed, and Khamil, Hyderabad; Ruttu Wuleed Minghu, Hyderabad; and Peranu, son of Jumu, Tatta."

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INDIA.

Hand-book by Dr. Birdwood.

Manchester, Coventry, and Paisley imitations of Indian chintzes, *kincobs*, and shawls. This is simply to deprave and debase English manufactures and English taste. No people have a truer feeling for art than English men and women of all classes, or purer elements of a national decorative style and methods; and the right and fruitful use of looking at superb examples of Indian jewelry, tapestries, and pottery is not to make literal copies of them, but to kindle the sense of wonder and imagination in us to nobler achievements in our own indigenous and industrial arts. Art at second hand is already art in its decay; while nothing serves to maintain its perennial spontaneity and purity like the inspiration which comes of the contemplation of the best examples of foreign art. European manufacturers should visit the Indian collection at the Paris Exhibition, not to slavishly plagiarize, but to receive a stimulating and elevating influence from the light and life of a traditional art still fresh and pure as at its first dawning two or three thousand years ago on the banks of the Indus and the Ganges."

Art at second hand condemned.

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FRANCE.

The following data relative to the ceramic industry of France are condensed from the official class-introduction published by the French Commission.

History of porcelain manufacture in France.

The first establishment for the manufacture of porcelain in France was at Vincennes. About the year 1730 the proprietors of these works moved them to Sèvres, and established there the manufactory which in 1739 was purchased by Louis XV, and has since remained the property of the state. These celebrated works have in connection with them a museum of ceramic art and products, where may be seen a complete collection of foreign-made porcelain, and of the materials used in their manufacture; a collection also of all the varieties of porcelain, *faïence*, and ordinary pottery of France, and of the earths, clays, and materials used in their manufacture. There is also a collection of models of vases, of ornaments, and of table services; also of samples of figures, statues, etc., which have been made at the establishment since its foundation.

Sèvres.

Museum and collections.

For the beauty of the materials, purity of design, elegance of the forms, and the rich ornamentation of the products, this establishment of Sèvres has long been the most important in Europe, and has powerfully stimulated and promoted the ceramic industry of France.

French centers of porcelain industry.

In France there are three principal centers of porcelain manufacture:

Limousin.

1. *Limousin* (*Haute-Vienne et Creuse*).—Limoges has more than thirty *fabriques* producing white porcelain.

Berry.

2. *Berry.*—Here are to be found the *fabriques* of Cher, of Allier, of Nièvre, and of Indre, which produce, chiefly, white porcelain and common objects of a low price.

Paris and vicinity.

3. *Paris and Its Environs.*—The Parisian manufacture comprises a great variety. There are a great number of small *fabriques* where they make fancy articles, such as flowers, cups, vases, baskets of flowers, etc. Others produce art objects, chiefly in biscuit ware, or special objects, such as decorative lamp-stands or vases destined to receive a rich ornamentation and to be mounted in carved wood or in bronze. There are, besides, numerous workshops where they receive plain white porcelain ware, coming, for the most part, from Saint-Arnaud-les-Eaux(Nord), and from Fontainebleau, and decorate it to order or to suit various special

Shops for decorating plain wares.

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PLATE 6.

FRANCE.
(Granite Figure by Solon.)

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PLATE 6.

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FRANCE.

purposes. The decoration is not made exclusively at Paris, but this branch of the art is essentially Parisian.

Porcelain *fabriques* in France.

There are in France 102 *fabriques* of porcelain, using a force equal to 1,300 horses (steam-engines to the extent of 550 horse-power, and water-wheels equal to 750 horse-power). They employ 14,000 workmen, and the value of the annual production is not less than 43,600,000 francs, or about $8,720,000. The value of porcelain products exported does not exceed 6,000,000 francs, against which there is a very considerable amount of British soft porcelain imported.

Power.

Workmen.

Product.

Materials.

The materials used in France for the manufacture of porcelain are the kaolins and white flint (pegmatites or petrosilex), of which the price varies from 8 to 14 francs the 100 kilograms, according to the quality. The typical kaolin is the plastic earth of Saint-Yrieix (Haute-Vienne); the kaolins of the Pyrénées, of Cher, and of Allier are used more and more with those of Limousin, and have contributed largely to the development of the *fabriques* of Berry.

Localities.

Porcelain earth alone, unmixed with other substances, does not give a suitable paste producing in the fire the translucency which should characterize porcelain. It is in the washed sands and in pure feldspar that the fusible element is found to which the translucency is due. This accessory product costs from 6 to 8 francs per 100 kilograms.

French faïence.

Faïence.

Composition.

The pastes or bodies of fine *faïence* are composed of pure white clay (that of Montereau, for example), of kaolin, and of feldspathic sand, and flint. Common *faïence* has for its elements marly sand and common clays, called "*terres franches*"; marly clays, loamy clays, and calcareous marls. The substances which form the base of the glaze are the same for the fine and the common *faïence*. These are silex, feldspar, the alkalies, minium, or white lead. In the better sorts of *faïence* boracic acid, a costly ingredient, is used to a considerable extent, and in the more common sorts oxide of tin is a cheaper ingredient, which gives a certain enamel-like opacity to the glaze and hides the dark or red color of the inferior clays.

Machinery

Machinery has been used for a long time past in the preparation of the materials, breaking, mixing, etc., and in the making of the pieces. There is not any new or important process or method to chronicle in the manufacture in France for the last ten years.

Centers of industry.

The most important centers of the manufacture of *faïence* are the Nièvre, Meurthe-et-Moselle, Seine-Inférieure, Loire-

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FRANCE. *Faïence.* Statistics.

Inférieure, etc. There are 372 establishments, which use a force of 542 horses and employ 5,430 persons, of which number 1,400 are women and children. The annual product is valued at 13,960,000 francs, or about $2,800,000.

Reproductions of ancient pottery.

A growing appreciation of the *faïences* of Nevers, of Rouen, of Beauvais, Lyons, and Moustiers, and a demand for similar products, has led to an extensive manufacture of reproductions of these famous and now costly and rare objects. The ancient forms and designs are successfully imitated at the *fabriques* of Grèu, Creil, Montereau, and Choisy-le-Roi.

Exportation.

The exportation of French *faïence* is not large, probably not exceeding 1,000,000 francs in value, while the importations from England are more than 3,000,000 francs in value.

Fine *faïence* is variously decorated, generally by transfer printing, and is often retouched by hand.

Coloring and glazing.

The common stanniferous *faïence*—*faïence* with the tin-oxide enamel or glaze—the majolicas, and other earthy bodies which are covered with this opaque glaze have acquired a great reputation by the brilliancy of the colors, the limpidity of the glazing, and the happy disposition of the paintings with which they are adorned. The Arabian, Persian, Oriental, and Moresque styles have been imitated, as well as the Italian and English.

Stone ware.

Stone ware.

Composition.

The better sorts made of fine materials serve for ornamental objects and are well adapted to table use. They are formed of a very fine paste, white or of various colors, are delicately fashioned, and often enriched with figures in relief, very neat and in paste of another color. Composed essentially of a pure plastic clay of kaolin and feldspar, this product is, by its nature, placed between hard porcelain and fine English *faïence*.

The paste of common stone ware, composed of fat clay with quartzose sand, gives very solid and strong ware, varying in color from a pearl-gray to a brown-red. It is dense and impermeable, resists the corrosive action of acids, and produces an excellent pottery for common use.

List of exhibitors.

LIST OF EXHIBITORS.

ABRAHAM (H.), *Versailles* (*Seine-et-Oise*). Decorated porcelain.

ALLIX (Dlles. M. et B.), *Paris*. Ceramic painting and enamels on copper.

ALLUAND, AÎNÉ. (Les héritiers de F.), *Limoges* (*Haute-Vienne*). Kaolins.

ANITA-HOREAU, *Levallois-Perret* (*Seine*). Cup and small porcelain box.

ARTIGUE FRÈRES, *Paris*. Art *faïence*.

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ATELIER D'APPLICATION DE L'ÉCOLE MUNICIPALE DES BEAUX-ARTS, *Limoges* (*Haute-Vienne*). Porcelain; *faïence*.

AUBERT (É), *Paris*. *Faïence* in all styles.

AUBRÉE (J.), *Sceaux* (*Seine*). Vases; *jardinières*; fancy objects in porcelain.

AUBRY (J.), *Bellevue* (*Meurthe-et-Moselle*). Artistic *faïence*.

AUCLERC (C.), *Auxerre* (*Yonne*). Artistic *faïence*.

AVISSEAU (É.), *Tours* (*Indre-et-Loire*). Statuettes; bass-reliefs; *faïences* Henri II; rustic pieces.

BALITRAND (L.), *Saint-Léger* (*Haute-Vienne*). Kaolins.

BAPTEROSSES (F.), *Briare* (*Loiret*). Objects in china paste; buttons, pearls, etc.

BARBIZET FILS (C.-A.), *Paris*. Art *faïence*, Bernard Palissy style.

BARBOT (Dlle. L.), *Orléans* (*Loiret*). Objects and pictures painted upon porcelain.

BARLUET ET CIE, *Paris*. All kinds of fine *faïence*.

BARREAU (L.), *Paris*. A variety of vases, *jardinières*, cups, plates, painted and decorated in soft paste porcelain.

BARTHE, DE GALARD, CLERE, ET CIE, *Vierzon-Village* (*Cher*). Different ceramic products, artistic pottery, and porcelains; terra-cotta statues and vases for gardens.

BAZIN (Dame H.), *Versailles* (*Seine-et-Oise*). Picture painted on porcelain.

BEAU (A.) ET PORQUIER (A.), *Quimper* (*Finistère*). *Faïence* with stanniferous glaze, *grand feu*, decorated on raw enamel.

BEAUFRÉ (Dlle. C.), *Paris*. Paintings on porcelain.

BELLION (Dlle. A.), *Paris*. Painting upon porcelain and *faïence*.

BENDER (Ve.), *Paris*. Decorated *faïence* and porcelain.

BERTHET (B.), *Murs* (*Indre*). Kaolins.

BÉZIAT (H.), *Paris*. Decorated vases in *faïence* or porcelain; pottery.

BLACHET, PALAYE ET REPELLIN, *Bourg-du-Péage* (*Drôme*). Kaolins.

BLOT (Dlle. A.), *Paris*. Painting upon porcelain and *faïence*.

BLOT (E.), *Boulogne-sur-Mer* (*Pas-de-Calais*). Groups, statuettes, pots, and pipes in terra cotta.

BLOT (J.-C.-E.), *Paris*. Painting *à l'engobe* upon panels and terra-cotta vases; paintings on stanniferous enamel.

BLOT (P.), *Paris*. Decorated porcelain.

BOCH FRÈRES ET CIE, *Paris*. Decorated tiles in stone-ware ceramic; pavements; letters on stone-ware tiles for signs; polished *faïence*.

BOCQUILLON (Dlle. A.-M.), *Meudon* (*Seine-et-Oise*). Plaques; sets of porcelain.

BODERON DE VERMERON (Dame), *Paris*. Plates in *faïence*.

BOHN (L.), *Paris* (*Vaugirard*). Terra cotta; decorative statues; bas-reliefs.

BOITELET (Dlle. M.), *Enghien* (*Seine-et-Oise*). Porcelain objects; artistic *faïence*, enameled.

BOISSIMON (C. DE), *Langeais* (*Indre-et-Loire*). Artistic pottery; *faïence* of all kinds; stone-ware.

BOMPARD FRÈRES ET CIE, *Lozoux* (*Puy-de-Dôme*). A variety of ceramic products; art and fancy pottery.

BONNAUD (F.), *Saint-Léger-la-Montagne* (*Haute-Vienne*). Kaolins.

BONNAUD (J.), *Saint-Léger-la-Montagne* (*Haute-Vienne*). Kaolins.

BONNAUD dit ROCHER, *Saint-Léger-la-Montagne* (*Haute-Vienne*). Kaolins.

BOSSOT (J.), *Ciry-le-Noble* (*Saône-et-Loire*). Ceramic products in china and stone ware; polished tiles; jugs; ink bottles.

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FRANCE.

List of exhibitors in Class 20: Ceramics.

BAUDARD (Dlle. M.), *Paris.* Paintings on porcelain.

BOULANGER (E.), *Paris.* Vitrifiable colors for ceramics.

BOULENGER (A.-J.-B,), *Auneuil* (*Oise*). Stone and marble ware; ceramic works with incrusted colors and of various designs.

BOULENGER (H.) ET CIE, *Choisy-le-Roi* (*Seine*). All kinds of *faïence;* monumental decoration in *faïence;* decoration in Arcade of Beaux-Arts in the Exposition; ornaments, landscapes, figures, on the plan of M. Jaëger.

BOUQUET (M.), *Paris.* *Faïence* painted on *émail cru.*

BOURGEOIS (E.), *Paris.* Decorated *faïence.*

BOUSSARD (D.), *Paris.* Porcelain flowers.

BOUTIN (Dame A.), *Paris.* Vases in enameled *faïence, grand feu.*

BRIANCHON, AÎNÉ, (J.), *Paris.* Porcelain and *faïence, nacré* and *changeante.*

CAGNANT (M.), *Granville* (*Manche*). Kaolins.

CAHOURS (Ve), *Paris.* Terra cotta and artistic *faïence.*

CAILLE (Dlle.), *Paris.* Artistic *faïence;* large panels in raw enamel; portraits, etc.

CALLIAS (Dame BENIGNA DE), *Paris.* Objects of industrial ceramic art.

CALMANT (E.-M.), *Paris.* Painted *faïence;* vase; panels, etc.

CARPEAUX (Ve), *Paris.* Artistic terra cotta.

CARRIER, *Paris.* Artistic *faïence.*

CARRIER-BELLEUSE ET CHÉRET (J.), *Paris.* Artistic ceramic products; figures, etc.

CELLIÈRE (L.), *Paris.* *Faïence;* reproductions on ceramic products of ancient arts in bronze and enamel; boxes and stands for flowers in French *faïence.*

CHAMEYRAS-REBEYROL (Dlle.), *Paris.* Paintings on porcelain.

CHAMPEIN (Ve A.), *Paris.* Plaques and dishes in *faïence;* painting on raw enamel.

CHAMPIGNEULLE (TH.), *Salvanges* (*Meuse*). Statues and ornaments in terra cotta.

CHAMPION (A.), *Paris.* Artistic *faïence;* vases, dishes, panels, lamps, shades.

CHARBONNIER FRÈRES, *Longchamp* (*Côte-d'-Or*). Tin-glazed *faïence;* ceramic products.

CHARLES-JEAN, *Paris.* Enamels; cups, flagon, etc.

CHARLOT FILS (J.-L.), *Paris.* Enameled jewelry on gold and silver; coffers, cups, ewers.

CHÂTENET (J.) FILS AÎNÉ ET CIE, *Angoulême* (*Charente*). Tiles and divers objects in decorated *faïence.*

CHEPMELLE (Dame), *Saint-Servan* (*Ille-et-Vilaine*). Painted porcelains.

CHEVALLIER (Dlle. C.), *Paris.* Paintings upon porcelain or *faïence.*

CLAUSS (M.-E.), *Paris.* Pieces of porcelain, enamel, and biscuit.

COBLENTZ (L.), *Paris.* Enameled objects upon gold, silver, and copper; *cloisonné* enamels and *champlevés;* paintings in Louis XV and Limosin style.

COLAS (C.), *Paris.* Artistic terra cottas.

CONSTANT (E.), *Millau* (*Aveyron*). Artistic terra cottas.

COOL (D. DE), *Paris.* Enamels and porcelains.

CORRET FILS, *La Roche* (*Haute-Vienne*). Kaolins.

COUTON (C.), *Clermont-Ferrand* (*Puy-de-Dôme*). Enamel *faïence* and porcelain plaques.

CROMMER (C.), *Paris.* Painting upon porcelain.

CUBERTAFON (H.), *Coussac-Bonneval* (*Haute-Vienne*). Kaolins.

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DALPAYRAT ET LOT, *Limoges* (*Haute-Vienne*). Enamels.

DAMMOUSE (A.), *Sèvres* (*Seine-et-Oise*). Porcelains decorated *au grand feu;* vases, cups, plaques, etc.

DARTOUT (P.), *Paris*. Porcelain flowers.

DAUBRON FRÈRES, *Paris*. Porcelains in all styles.

DEBAECKER (L.), successeur de VOGT, *Paris*. Mantle-piece in enameled *faïence;* stove *faïence*, Renaissance style.

DECK (T.), *Paris-Vaugirard*. Decorated and common vases; plates; architectural decorations; monumental decoration in *faïence;* decoration of two arches of the Porch of the Beaux-Arts, Nord Palace, Champ de Mars; landscapes; figures on a large scale, according to the plans of M. Jaëger, architect.

DECOUX (A.), *Saint-Léger-la-Montagne* (*Haute-Vienne*). Kaolins.

DEJEY (J.-M.), *Gières* (*Isère*). China vases decorated by hand.

DELAISSE (H.), *Paris*. White or decorated *faïence;* inlaid mosaic ware; *faïence* plaques or panels, white or decorated.

DELFORGE (E.), *Paris*. Decorations upon porcelain and *faïence*.

DELTENRE (N.), *Hautmont* (*Nord*). Works of art in terra cotta; hanging flower vases.

DEMANCHE (A.), *Paris*. Artistic *faïence*.

DEMARTIAL ET TALANDIER, *Limoges* (*Haute-Vienne*). Porcelains; *faïence*.

DEMILLY (C.), *Vichy* (*Allier*). Galo-Romaine pottery.

DENUELLE (C.), *Saint-Yrieix* (*Haute-Vienne*). Kaolins.

DESENFANTS-BARTHÉLEMY, *Saint-Léger-la-Montagne* (*Haute-Vienne*). Kaolins.

DETEMMERMAN (P.), *Paris*. Porcelain flowers.

DIFFLOTH PÈRE (A.), *Charenton* (*Seine*). Artistic porcelain; imitations of Chinese and Japanese porcelains; objects sculptured in bass-relief by mechanical process.

DORÉ (A.), *Billancourt* (*Seine*). Lamps; vases; flower stands and panels of decorated white *faïence*.

DUBOIS (A.) PÈRE ET FILS, *Paris*. Artistic *faïence* with colored impaste.

DUCHESNE (Dlle. V.), *Paris*. Paintings on porcelain.

DUBOUSSET FRÈRES, *Eschassières* (*Allier*). Kaolins.

DUFLOT (E.), *Paris*. Statuettes in terra cotta, enameled.

DUNOYER (Ve A.), *Coussac-Bonneval* (*Haute-Vienne*). Kaolins.

DURAND (Dlle.), *Paris*. Decorated porcelains.

ERNIE ET LIGNARD, *Paris*. Decorated porcelains and *faïence;* enamel style of old Limoges, on *faïence* and porcelain.

ESPEUILLES (Marquis D'), *Saint-Honoré-les-Bains* (*Nièvre*). Stone ware of Saint-Honoré-les-Bains.

ETIENNE (V.), *Paris*. Decorated porcelain; table services; vases.

FAÏENCERIE DE GIEN (administrateur, G. GONDOIN), *Gien* (*Loiret*). *Faïence* in all kinds, white, decorated, and artistic.

FEHRENBACH (M.), *Paris*. Artistic *faïence*.

FOULLON (E.-E.), *Prés-Saint-Gervais* (*Seine*). Artistic porcelain; *faïence*.

FOULQUIÉ, *Paris*. Three small paintings in ceramics.

FOUREAU (Dlle. M.), *Frédières* (*Haute-Vienne*). Plaque of porcelain, representing flowers.

FOURMAINTRAUX-COURQUIN, *Desvres* (*Pas-de-Calais*). *Faïence* and tiles.

FROMENTIN (J.), *Paris*. Dishes in *faïence* and plaques for ornamenting furniture.

GABARET (F.), *Saint-Léger-la-Montagne* (*Haute-Vienne*). Kaolins.

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FRANCE.

List of exhibitors in Class 20: Ceramics.

GADAUD (J.), *Saint-Léger-la-Montagne* (*Haute-Vienne*). Kaolins.

GAIDAN (F.), *Paris*. Artistic *faïence*.

GALLÉ, *Nancy* (*Meurthe-et-Moselle*). Models in *faïence*.

GAUNET, MARI, GUIRARD, ET CIE, *Vallauris* (*Alpes-Maritimes*). Refractory culinary pottery.

GAUVAIN, *Paris*. Decorated porcelain.

GERMAIN (L.), *Saint-Léger-la-Montagne* (*Haute-Vienne*). Kaolins.

GIBUS ET REDON, *Limoges* (*Haute-Vienne*). Porcelain; *faïence*.

GILLE (E.), *Paris*. Artistic *faïence*.

GILLET (F.), *Paris*. Painting on enameled lava; products in enameled lava applied to industries; decoration in painting on enameled lava on the arch under the porch of the Section of Beaux-Arts; large medallion after Raphael.

GINDRE (J.), *Itsatsou* (*Basses-Pyrénées*). Kaolins.

GIRARD (A.), *Aprey* (*Haute-Marne*). Decorated *faïences*.

GIRAUD (E.), *Paris*. Porcelain flowers and bouquets.

GIRAULT (P.), *La Borne* (*Cher*). Pottery.

GODIN (J.) ET DELAHERCHE, *la Chapelle-aux-Pots* (*Oise*). Vases and apparatus in stone ware for chemical work.

GONTRAN-ESNARD (Dame), *Paris*. Vases, dishes, plates, cups of Sèvres porcelain and soft paste.

GOSSART (F.-J.), *Paris*. Articles enameled on copper, decorated and mounted in bronze; vases; cups; round tables; little boxes; ornaments for bureau.

GOSSE (Ve P.), *Bayeux* (*Calvados*). Hard porcelain; household articles; capsules; crucibles; chemical ware.

GOSSIN (É.), *Paris*. Terra-cotta vases, statues, and groups.

GOUILLET (J.), *Paris*. Artistic *faïence*.

GRANIER (Dlle.), *Paris*. A portrait painted upon porcelain.

GRÉBER (P.), *Beauvais* (*Oise*). Stone-ware and terra-cotta pottery.

GRENIER (F.), *Paris*. Mosaic tiles and ceramic products.

GRILLET, *Paris*. Scent bottles ornamented in gold and silver.

GRIMAL (P.), *Millau* (*Aveyron*). Terra-cotta vases, cups, and statuettes.

GRINCOURT (Z.), *Paris*. Artistic porcelain and *faïence*.

HACHE (A.) ET PEPIN-LEHALLEUR BROTHERS, *Paris*. Decorated and mounted white porcelains.

HAINAUT (A. D'), *Paris*. Two *faïence* dishes, ceramic painting.

HARLÉ (J.-A.), *Montreuil-sur-Mer* (*Pas-de-Calais*). Little terra-cotta pictures.

HAUET (E.), *Paris*. Kaolins.

HAVILAND ET CIE, *Limoges* (*Haute-Vienne*). Porcelains and *faïences*.

HORIOT (Dlle.), *Neuilly* (*Seine*). Artistic porcelain.

HOURY (C.), *Paris*. Ceramic products; decorated panels; artistic vases.

HOURY (J.), *Paris*. Artistic *faïence*.

HUART (P. D') FRÈRES, *Longwy* (*Meurthe-et-Moselle*). *Faïence* in all kinds, fine, white, decorated, and artistic.

HUBAUDIÈRE (DE LA) ET CIE, *Quimper* (*Finistère*). China stone ware; stanniferous *faïence*.

HUGARD (Dlle. C.), *Paris*. A *faïence* dish, with subject in the middle and ornaments around.

HUTAN (J.-B.-E.), *Armentières* (*Oise*). Stone-ware vases for chemical work, tubes, etc.

HUVELIN (G.), *Paris*. Artistic *faïence*; dishes; plates.

JACOBBER (E.), *Paris*. Painted porcelain; enamel paints; fans.

JULLIEN (A.-G.). *Paris*. Table services.

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FRANCE.

List of exhibitors in Class 29; Ceramics.

JUMON (Dlles. A.), *Paris.* Porcelain and *faïence.*

KLOTZ, *Paris.* Decorated porcelain; large vases; table services.

KOUSTANGA-BOULARD (Dame), *Paris.* Painting on *faïence.*

LABARRE (Ve A.), *Font-Quentin* (*Loire*). Fountains; flower vases; household stone ware.

LACROIX, *Paris.* Vitrifiable colors; painting on porcelain.

LADREYT (E.), *Paris.* Humorous figure; *terre cuite.*

LAFONT (M.), *Paris.* Dishes; decorated vases.

LAMONNERIE ET BOBILLOTT, *Paris.* Bright gold on porcelain; *faïence* and stone ware.

LANDRY (F.), *Paris.* Decorations on artistic *faïence.*

LANGERON (P.), *Pont-des-Vernes* (*Saône-et-Loire*). Stone ware of various colors; fire-bricks.

LAPRADE (P.), *Saint-Léger-la-Montagne* (*Haute-Vienne*). Kaolins.

LAROCHE, *Paris.* Artistic *terre cuite* of various great artists; statuettes, bass-reliefs, vases, etc.

LAURIN (F.), *Bourg-la-Reine* (*Seine*). Artistic *faïence.*

LECLAIRE (L.-L.), *Paris.* Painted *faïence* on brown enamel.

LECLERE (L.-F.), *Vivier-Danger* (*Oise*). Vases decorated in glazed ware; wainscoting and panels.

LECORNEY ET PAILLARD (V.), *Paris.* Artistic *terre cuite.*

LE FLOCH (Dame L.), *Figeac* (*Lot*). Painting on porcelain.

LEFORT (A.) ET JOUVE (A.), *Marlotte* (*Seine-et-Marne*). Decorated panels on lava; paintings, enameled or dead; medallions, borders, etc.

LEFRONT (A.-T.-M.), *Fontainebleau* (*Seine-et-Marne*). Ceramic products.

LEGRAND (P.), *Paris.* Painting on porcelain.

LÉOBARDY (A. DE), *La Jonchère* (*Haute-Vienne*). Kaolins.

LESUEUR (C.-L.), *Paris. Terre-cuite* vase.

LESUEUR (Dlle. C.), *Paris.* Paintings on porcelain and *faïence.*

LEVÊQUE (P.), *Vallauris* (*Alpes-Maritimes*). Enamel on *faïence.*

LÉVY (C.), *Charenton* (*Seine*). Artistic porcelain; *faïence.*

LÉVY (E. et C.), *Paris.* Vases, imitation of old Sèvres.

LŒBNITZ (J.-P.), *Paris.* Stoves and *calorifères* in artistic *faïence;* vases; decorative pieces; artistic bricks; *terre cuite* and enamels, after the design of M. Paul Sédille, under the porch of the Beaux-Arts Section.

LORDEREAU (A.), *Paris.* Bricks in decorative French *faïence.*

LOUIS (J.), *Paris. Faïence;* stone ware; majolica; sculpture.

LOUTREL (Dlle.), *Levallois-Perret* (*Seine*). Artistic ceramics.

MACÉ (L.-A.), *Paris.* Decoration on porcelain and *faïence* by chromolithographic process.

MACHEREAU (J.), *Paris.* Soft porcelain, decorated; vases; flower stands.

MAJORELLE (A.), *Nancy* (*Meurthe-et-Moselle*). Vases, *cache-pots,* and flower stands; lacquer on *faïence* and biscuit.

MANSARD (Ve.), *Paris.* Decorated porcelain.

MANUFACTURE DE FAÏENCE DE SAINT-CLÉMENT (Director THOMAS), *Saint-Clément* (*Meurthe-et-Moselle*). Fancy articles and *faïence* of Lorraine, decorated and plain.

MARMET (J.-L.), *Ferney-Voltaire* (*Ain*). Earthen vases, ornamented with flowers in relief.

MARSAT (J.), *Saint-Léger-la-Montagne* (*Haute-Vienne*). Kaolins.

MAUGER ET FILS ET LETU FILS, *Paris.* Fancy articles and flowers in in porcelain.

MAUSSION (Dlle. E. DE), *Paris.* Porcelain enamel miniature.

MÉNAGER (A.-G.), *Paris.* Artistic *faïence.*

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FRANCE.

List of exhibitors in Class 20: Ceramics.

MENON (Dlle. M.), *Levallois-Perret* (*Seine*). *Faïence;* portraits on porcelain; miniature; painting on glass.

MERCIER-PAGEYRAL, *Tayac* (*Dordogne*). Kaolins.

MEYER (A.), *Paris.* Paintings on enamel.

MILET (O.) ET MASSIER (C.), *Sèvres* (*Seine-et-Oise*) and *Vallauris* (*Alpes Maritimes*). Artistic *faïence.*

MINISTÈRE DE L'INSTRUCTION PUBLIQUE ET DES BEAUX-ARTS (Manufacture national de Sèvres). Porcelain in soft and hard paste; enamels; biscuit. (Special catalogue).

MONNIER (F.), *Foëcy* (*Cher*). Porcelain in variety.

MONTAGNON (A.), *Nevers* (*Nièvre*). Decorated *faïence;* vases, flower stands, etc.

MOREAU (Dame C.), *Paris.* Dishes and vases in *faïence.*

MOREAU (E.) ET TRISTAN, *Paris.* Artistic and decorated *faïence.*

MORVAN, *Arles* (*Bouches-du-Rhône*). Kaolins.

MOUSSU (T.), *Levallois-Perret* (*Seine*). *Faïence* plaques; portraits on porcelain.

MULLER ET CIE, *Ivry* (*Seine*). Enameled *terre cuite.*

NATUREL (F.), *Paris.* Cups of painted *faïence.*

NUGENT (Dlle. M. DE), *Prés-Saint-Gervies* (*Seine*). Enamels and paintings on enamel.

OLLENDON (Dame D'), *Paris.* Painting on porcelain.

ORILLAT FILS AÎNÉ, *Azy-le-Vif* (*Nièvre*). Kaolins.

OUTI (M.), *Paris.* Flowers in porcelain, of all kinds.

PACHAUD (A.), *Saint-Léger-la-Montagne* (*Haute-Vienne*). Kaolins.

PANNIER-LAHOCHE ET CIE, *Paris.* Decorated porcelain; artistic *faïence;* enamels; cups, vases, etc.

PARROT (E.) ET CIE, *Turenne* (*Corrèze*) Kaolins.

PÊCHE, *Paris.* Models in *terre cuite* for ceramics.

PÉRICHON (Dlle. M.), *Paris.* Painting on porcelain and *faïence.*

PETIT (M.), *Paris.* Painted porcelain plaque.

PEULLIER (L.), *Paris.* Artistic porcelain, white and decorated; busts and statuettes in *terre cuite.*

PEYRUSSON, *Limoges* (*Haute-Vienne*). Porcelain, *faïence,* and vitrifiable colors.

PILLIVUYT (C.) ET CIE, *Paris.* Hard-paste porcelain, white and decorated.

PINOT (Ve V.-N.-A.), *Paris.* Flowers of all kinds in porcelain.

POIRET (R.-U.), *Paris.* Enamel color for goldsmiths and art bronzes; panels.

PONSIN (F.-A.), *Paris.* Art *faïence.*

POUYAT (É.), *Limoges* (*Haute-Vienne*). Porcelain; *faïence;* kaolins.

POYARD (C.), *Paris.* Artistic *faïence.*

PUISOYE (Dlles. M. et M.), *Paris.* Enamels and art *faïence.*

PULL (G.), *Paris.* Decorated ceramic products.

QUINTER, *Paris.* Fancy porcelain.

REVOL (G.) PÈRE ET FILS, *Saint-Uze* (*Drôme*). Fine and common stone ware; articles in terra cotta.

RICHARD (Dame), *Paris.* Vases and cups; decorated porcelain.

RICHARD-GODIN (C.-A.), *l'Héraule* (*Oise*). Glazed stone-ware pipes and pottery; vases and apparatus in stone ware for chemical uses.

RIGAL ET SANEJOUAND, *Clairefontaine* (*Haute-Saône*). Artistic and fine *faïence;* majolica.

RIVIÈRE (A.-J.-O. DE), *Bourg-la-Reine* (*Seine*). Artistic pottery; vases; flower stands; tiles.

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ROBILLARD (A.), *Paris.* Enamels.

ROCOFFORT (A.), *Toury-Lurcy* (*Nièvre*). Fine pottery.

ROLLÉ (A.), *Paris.* Objects of art in *terre cuite*, busts and statuettes.

ROUGET (Dlle. C.), *Paris.* Painting on porcelain and *faïence.*

ROUSSEAU (E.), *Paris.* Decorated porcelain and *faïence.*

ROY (G.), *Paris. Faïence.*

SAFFROY (Dlle.), *Paris.* Artistic *faïence.*

SAILLAC (Dlle. C.), *Paris.* Decorated porcelain.

SAMSON FILS AÎNÉ (É), *Paris.* Large vases in imitation of old china; large dishes; *cloisonné* vases with bronzes; accessories, such as handles and feet.

SAND ET CIE, *Feignies* (*Nord*). Tiles decorated by incrustation.

SAZERAT (P.-L.-É.), *Limoges* (*Haute-Vienne*). White and decorated porcelain; kaolins.

SCHOPIN (E.), *Montigny-sur-Loing* (*Seine-et-Marne*). Artistic *faïence;* vases; dishes; plaques.

SCRIBE (L.-O.), *la Ferté-Saint-Cyr* (*Loir-et-Cher*). Dishes in the Italian style of the sixteenth century, painted on raw enamel, *grand feu.*

SERGENT (T.-V.), *Paris.* Vases; flower stands; small boxes; decorated dishes in majolica.

SIMONS ET CIE, *Cateau* (*Nord*). Mosaic bricks in fine stone ware; pavement of the pavilion of the Minister of Public Works.

SIMPSON (Dlle. A.-E.), *Paris.* Artistic ceramic work.

SOCIÉTÉ DES FABRICANTS RÉUNIS DE VALLAURIS (*Alpes-Maritimes*). Pottery.

SOCIÉTÉ ANONYME DES KAOLINS DE L'ALLIER, *Collettes* (*Allier*). Kaolins.

SOUCHET-DUMONT (Vc.), *Bourges* (*Cher*). Artistic pottery, statues, and incrustations for furniture.

SOUCHET ET CIE., *Paris.* Enamel flowers.

SOYEZ (P.), *Paris.* Objects of art in enamel; ewers; cups; dishes; *bonbonnières, bijouterie.*

TARGET (Dlle. M.), *Paris.* Decorated porcelain.

THIBAULT (A.), *Chaussée-Saint-Victor* (*Loir-et-Cher*). Artistic *faïence.*

THIERRY (G.), *Paris.* Porcelain and *faïence* decorated for table service.

THOMAS (A.), *Paris.* Vases of all forms; Chinese vases; flower-pot holders; toilette objects.

TORTAT (J.), *Blois* (*Loir-et-Cher*). Artistic *faïence.*

ULYSSE-BESNARD (J.-J.), *Blois* (*Loir-et-Cher*). Decorated *faïence.*

UTZSCHNEIDER ET CIE, *Digoin* (*Saône-et-Loire*). Articles in hard *faïence* (opaque porcelain), white and decorated.

VAUX-BIDON (Dlle. DE) *Paris.* Painting on porcelain.

VIEILLARD (J.) ET CIE, *Bordeaux* (*Gironde*). *Faïence,* ordinary and fine; table and toilet services.

VIGNON (C.), *Paris-Passy.* Statuettes in enameled *terre-cuite.*

VION (D.) ET BAURY, *Paris.* Statues; statuettes; vases; *candélabras; pendules.*

VIREBENT FRÈRES ET FILS, *Toulouse* (*Haute-Garonne*). Mantel decorations; architectural objects in stone ware; wall-facing in painting on enameled *faïence;* decorated facing on the arch under the entrance to the Beaux-Arts Section; architectural railing.

VIVIEN (E.), *Neuvy-sur-Loire* (*Nièvre*). Salt-glazed stone ware.

WOODCOCK (F.), *Paris.* Flowers and bouquets in porcelain.

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NOTICES OF SOME OF THE PRINCIPAL EXHIBITS.

PORTE DES BEAUX-ARTS.

Porte des Beaux-Arts.

Jules Lœbnitz.

JULES LŒBNITZ.

This magnificent entrance porch to the Gallery of Fine Arts opposite the end of the building put up by the city of Paris, is executed in red terra cotta, with enameled panels or tiles of huge dimensions inserted in the sides and the frieze at the top. The total height is 12 meters, about 40 feet, and the breadth 11 meters. It was erected under the direction of the architect Paul Sédille, but all the enamels were made by Jules Lœbnitz, the manufacturer of artistic *faïence* for architectural uses, and constitute his exhibit.

Paul Sédille.

Terra-cotta moldings.

The elaborately carved and ornamented sides and top moldings of the red terra cotta are relieved with gilding on the raised ornaments, and with medallions of female heads at intervals. The enameled slabs and pieces, of which there are about 300 in all, are of unusual size, and required specially constructed ovens to bake them in. The enamels were applied after the first baking. The three upper panels, representing painting, architecture, and sculpture, are each about three feet square. The largest panel measures 1^{m}.15 square. The panels below at the sides are made up of three whole and two half size slabs, each one about 30 by 23 inches. The designs are sharply lined in grafito. This makes a division in the enamel colors which do not flow over and coalesce. All the enamels are very smooth and perfect, and the colors are good; green, white, and dark brown predominate. The cartoons for the frieze were drawn by Émile Lévy. The cost of the whole was about 50,000 francs.

Enameled slabs of unusually large size.

Excellent colors.

Émile Lévy.

Barluet & Co.

BARLUET & CO.

The establishments for the manufacture of *faïence* at Creil and Montereau are, since the loss of Sarrequemines, the largest in France. The manufacture at Montereau was established in the year 1775, that at Creil in 1794, and by their union in 1840 the ownership has descended to the firm of Barluet & Co. At present 18,000 tons of coal are required annually for these works. Two water-wheels and seven steam-engines represent a force of 250 horses, required to move the machinery of the mills, presses, and mixing apparatus. Five hundred operatives are employed. Twenty-three millions of pieces are sent out annually, and the value of the product or extent of the annual expenditure is 3,500,000 francs.

Established in 1775.

Progress of the manufactory.

Statistics.

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In the very extensive representation of the superior products of this immense establishment I note especially the large specimen of decoration in *pâtes rapportées* and the large panel for wall decoration, representing a forest with the trees of the natural size and color, with groups of hunters and mounted cavaliers.

Barluet & Co.

Pâte rapportée.

M. Barluet has been honored with the Cross of Chevalier of the Legion of Honor, and is recognized as a most devoted promoter of the industry of *faïence.*

POUYAT'S PORCELAIN.

Pouyat.

The finest white porcelain in the Exposition, rivaling in purity that of Sèvres, was shown by Pouyat. The dinner services were remarkable, not only for the perfect whiteness and translucency of paste, but for the accuracy of form of the pieces, their lightness, and luster. The "rice porcelain," or perforated ware, was shown in quantity, whole services being made of it, plates, tureens, and fruit-dishes. It appeared to be fully equal to the white hard porcelain perforated ware shown from the government establishment at Sèvres.

Fineness of material and accuracy of form.

Perforated ware.

Pouyat also exhibited a very superior ivory porcelain, notably in some large circular plaques decorated, and the broad tile background of his installation. These tiles were decorated with foliage in relief, and a vine with fruit in delicate green and purple with gold. There were also some very good specimens of *pâte-sur-pâte.*

Ivory porcelain.

Pâte-sur-pâte.

HAVILAND & CO.

Haviland & Co.

The exhibit of Haviland & Co., of Limoges, was very large, and comprised their various products of porcelain, both of the hard and soft paste bodies, and a full line of the decorated *faïence* for which their *fabriques* are so well known. Many of the *faïence* vases were like those shown at Philadelphia in 1876. Vases with broad flat sides are now more in vogue, being better adapted to the reception of the paintings. One of the novelties is the introduction of figures in relief in the biscuit unglazed rising above the highly decorated and glazed surface.

Decorated *faïence.*

Unglazed figures in relief above a decorated glazed surface.

There are some beautiful pink-colored vases and some of turquoise-blue, with accidental patches of ruddy scarlet red, flame-like, upon the sides.

One large rectangular *jardinière* is 3 feet long and 20 inches high, and is decorated on the side by Conturier, who has painted a life-size group of chickens and guinea fowls.

Conturier.

The firm also exhibits vases in soft porcelain—*pâte-tendre*—in many forms.

Pâte-tendre.

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FRANCE.

Faïence.

Haviland & Co

Visitors to the Centennial in 1876 will remember the fine specimens of *faïence* which were shown there and the two large memorial vases in enameled *faïence* which, at the close of the Exhibition, were presented by the firm to the ceramic department of the National Museum at Washington. These vases were afterward set up in the hall of the Smithsonian alongside of the Doulton terra-cotta pulpit and the terra-cotta group "America."

Memorial vases in the Washington National Museum.

The following description was supplied to the writer by the Messrs. Haviland:

History of the work.

Materials used.

"Work was commenced in 1873 on the specimens now exhibited for the first time. They are made of common earthenware clay, and are decorated with colors and enamel, the brilliancy of which has never been surpassed on any kind of ware yet made. All the forms and decorations are by well-known artists.

"When it is remembered that all these colors have passed through fire, the effect produced is wonderful, and must be interesting to all lovers of ceramic art. The principal pieces in the collection are two large vases, commemorative of the Independence of the United States, and of the completion of their first century of existence as a nation. They are the largest vases ever made in Europe, and no idea of the difficulty of their manufacture can be conveyed to any one who has not attempted a work of like importance.

The vase "1776."

"The vase '1776'—'The Struggle'—has for its base a barren rock, washed by angry waves. On top is a battery of cannon, modeled from those in use during the Revolutionary war, the idea conveyed being disorder. On the body of the vase is an eagle, with outspread wings. On either side the colors of the United States. Above the eagle are the names of the signers of the Declaration of Independence. The vase is surmounted by a bust of Washington. On the one side is a statue of 'Victory' and on the other 'Renommée.'

The vase "1876."

"The vase '1876'—'Prosperity'—has for its base emblems of peace, the fruits of the earth, and the implements of industry. On the body are the eagle and the colors, and above are the names of the Presidents of the United States, with their terms of office. On top is a bust of 'America' and on each side are the 'Victory' and the 'Renommée.' The vases were designed by Bracquemond, late director of the ateliers at Sèvres. They were sculptured by Delaplanche, 'Grand prix de Rome' and Chevalier of the Legion of Honor.

Delaplanche.

Panel of Limoges faïence.

Panel of Limoges *faïence.*

Bracquemond.

"Between the vases is a large panel composed of over 900 tiles, designed and painted by Bracquemond. The picture is allegorical, and represents the genius of man utilizing the waters of the rebellious stream and storm, the fires of the volcano and lightning, and making them the willing slaves of progress. The coloring of these tiles resembles that of an oil-painting, and the effects are different from any heretofore produced with the same materials. In this connection it may be mentioned that M. Garnier, architect of the Academy of Music in Paris, has ordered two panels to be placed in one of the rooms of his theater.

"There are many specimens of vases showing the most wonderful coloring that has ever been produced, and the forms, having been designed by skillful artists, are very remarkable. A few of these deserve special

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mention, as they are works of such artists as Eugène Delaplanche, Tony Noël, Edouard Lindencher, and Felix Lafon. These cannot be duplicated, as no molds were ever made for them. The very same vase that was sculptured by the artist was colored, then fired, and placed on exhibition."

FRANCE. *Faïence.*

GIBUS & REDON.

Gibus & Redon.

The works of this firm are at Limoges, and their salesrooms at Paris.

They manufacture and exhibit a great variety of ordinary porcelain table services of excellent quality and low price. The paste is beautifully white. Many of their products are sent to Japan and are there decorated by the Japanese and then returned to Europe or America

Table services.

They exhibit also many very fine examples of vases in colored porcelain, decorated with colored pastes and slips and with white *pâte-sur-pâte.* Some of the vases are of white body with an exterior coating, the most satisfactory being the pale lavender or pearl color. The vases are thrown, turned, not molded. All the white paste decorations are beautiful and excellent, so far as the perfection of the paste, its softness, purity, and fineness, are concerned, but the drawing and attitudes of the figures are bad. The figures appear stiff and constrained, and are without that airy grace and ethereal beauty which mark the work of Solon. On one pair of vases we have female figures delicately draped; on one vase one of the nymphs is riding in a chariot in the clouds and is drawn by butterflies; on the other vase the nymph is in a shell drawn by two dolphins. The first is delicately draped in a thin gauze-like veil of blue, and the second has a thin drapery of a pale celadon-green color. These *pâte-sur-pâte* decorations are the work of F. Peyrat.

Vases decorated *pâte-sur-pâte.*

F. Peyrat.

On another pair of vases Cupids are represented climbing after birds. It is superb as respects technique, but is stiff and constrained in the attitudes.

A dish with lavender ground or paste and a white *pâte-sur-pâte* decoration of female figures, writing on a tablet while the muse pours oil into a tall Roman lamp, is perhaps the best piece. It is signed F. Peyrat.

Decorated vases and dishes.

The best success is obtained in *pâte-sur-pâte* with flowers as the subjects, or with medallions. A pair of delicately colored celadon vases, with dark lavender-color medallions, on which are busts of females surrounded by arabesques and griffins, gave great satisfaction.

Some black vases elaborately decorated with white paste had all the appearance of onyx cameo. There were also some very pleasing jewel-boxes in the same style and in

Onyx effect.

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FRANCE.

pastes of lavender and celadon, all mounted in gilt metal frames.

Deck's *faïence*.

DECK'S FAÏENCE.

Superb reproductions of Oriental vases and enamels.

By common consent the productions of Deck bear off the palm of excellence and artistic merit. His vases and plaques and reproductions of Persian and Japanese art-pottery and his enamels are unsurpassed. Many of the designs of vases are taken from Buddhic bronze vases of China and Japan. T. Deck was one of the fortunate three to receive the grand medal.

Grand medal.

Gien *faïence*.

GIEN FAÏENCE.

The old establishment of Geoffroy & Co. is now known under the name of *Faïencerie de Gien*, owned by a stock company with a capital of 1,800,000 francs. Their productions include not only the ordinary ware for household use, but a great variety of artistic *faïence* and reproductions of ancient decorative *faïence*.

These works owe their origin to Mr. Hall, who had before been engaged in the potteries of Montereau. In the year 1820 he founded the works of Gien on the banks of the Loire, in the buildings of an ancient convent. At first a *faïence* was made with a composition resembling the British stone-china ware, but even at that time, although the products of Gien were remarkable for their whiteness, they were far from having the solidity of paste and the hardness of enamel since obtained, and which now permits it to compete with porcelain for domestic purposes.

Founded by Hall in 1820.

Hard *faïence*.

The manufactures of Gien comprise two distinct branches. The one the most ancient and important consists of objects of household use for every-day domestic purposes, such as table and toilet services, either white or decorated by painting or printing.

White, painted, or printed domestic services.

The second, which originated in 1856, consists of artistic products for decorative purposes, and of reproductions of *faïence* of ancient and popular designs. The first to be imitated was the table services of old Rouen, and this meeting with great success, was followed by imitations or reproductions of Delft ware, the *faïence* of Moustiers, of Marseilles, of Neiderviller, and of Italy. To these were added, later, imitations of the ancient *faïence* and enamels of Persia, China, and of Japan, including *cloisonnés*, *craquelés*, turquoise-blue, and *blue de Sèvres*. At the same time the manufacture of ordinary ware has not been neglected. The quantity made has increased from year to year.

Artistic and decorative *faïence*.

Reproductions of Delft, Italian, Persian, Chinese, and Japanese wares and enamels.

In 1866 the company decided to tear down the ancient

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buildings and to build anew. The new works were fitted with every desirable modern appliance, and at present they employ a motive power equal to 220 horses in crushing and mixing the materials, and in turning, pressing, and molding. Besides the special works for these purposes, they have workshops for all the trades tributary to the work. The works employ a thousand or more workmen, including 200 decorators. The superficial extent of the establishment is 50,000 square meters. More than 25,000 kilograms of *faïence* is sent out daily, and no less than 50,000 plates have been made in one day.

Gien *faïence.*

Statistics of the works.

The plastic clays are procured from Nièvre and Champagne, the kaolins from Allier, the feldspar from Auvergne, and the coal from Bézenet. Of the latter 35,000 kilograms are used daily. The temperature of the biscuit furnace is estimated at 1,800 degrees centigrade, and the baking requires three days, not including the cooling, which requires four or five days longer. The baking fire for the enamels is not so strong and the furnaces are smaller than those for the biscuit, thus permitting a shorter time for the baking and the cooling.

Locality of the materials used.

Biscuit and baking furnaces.

The company exhibits a great variety of its products, among which may be noted imitations of Japanese ware, especially Satsuma and Kioto *faïence*, also enamels like the Longwy, and large pieces of *faïence* in the style of Haviland vases, and large square and round plaques, some of them 1^{m}.20 in diameter.

Articles exhibited.

The welfare and contentment of the operatives and their families have received much care from the company. Schools are established in which the instruction is gratuitous, and the children are taught for three hours daily. Those who pass a prescribed examination are selected to assist in teaching.

Welfare of operatives.

A society is formed for the support of sick and disabled workmen, and has been of great service. There is also a band of 50 musicians, and it has recently received a gold medal at Paris. The company also distributes 10 per cent. of its net profits yearly to the most deserving of its employés and workmen.

Provision for sick and disabled.

Distribution of percentage of profits.

The merit of the Gien products has been recognized at the successive great exhibitions by bronze and silver medals, gold medals, and diplomas of honor.

Medals.

LONGWY ENAMELS.

The enamels of Longwy, which a few years ago were rare, are now abundant and familiarly known in the United

Longwy enamels.

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States. There was a very large and beautiful display at the Exposition of the choicest products of this establishment. Among the largest are a table-top in one slab 3 feet 8 inches long and 2 feet wide. It was very flat and the enamel surface was very even and well formed. The groundwork of the central portion was in *craquele* and the outer border was in plain enamel. This alone served to show the mastery which this *fabrique* has obtained over the enamels. A pair of vases 4 feet high and 20 inches in diameter, in Chinese style, is also worthy of mention. Enameled circular plaques were shown in variety, from 8 inches to 3 feet in diameter. Some large panels were decorated with highly colored flowers on an intensely black enamel background. Among the smaller objects we note *jardinières*, vases, flowerpots with inner linings of metal, and trays of all sizes. They have obtained a very brilliant carmine-red enamel color, ruby-like in its luster, adding greatly to the brilliancy of their enamels.

Longwy enamels.

Table and vases.

Large plaques, panels, etc.

Works founded in 1798.

These works, founded in 1798, enjoyed at their birth the traditions of the art of the period of Louis XVI, and commenced by the production of *chefs-d'œuvre* in relief, and white enamel imitations of antique busts and vases, of which specimens may be seen in the ceramic museum at Sèvres. At present the number and brilliancy of the colored enamels exceed those known to Oriental potters.

H. D'Huart.

Gold medal.

M. H. D'Huart, one of the proprietors of the establishment, received, in addition to the gold medal, the honor of the Cross of the Legion of Honor. The artistic services of Mr. Charles Lonquet were recognized by a silver medal.

Chas. Lonquet.

Enamels on lava.

Enamels on lava.

An unusual ceramic product is presented to us in the form of vitreous enamels in colors upon pumice-stone lava, not only in the Japanese section, but in the French. In the latter, M. F. Gillet, 9 Rue Fénélon, Paris, exhibited an important specimen under the porch at the right of the Pavilion des Beaux-Arts, near the Russian section. This specimen, 8m.50 long and 2m.50 high, is an exact reproduction of one of the works of the painter Flandrin, deceased, executed in the church of St. Vincent de Paul at Paris. In executing this copy M. Gillet desired to prove that lava is one of the best foundations known for enamels, and especially suitable to the interior and exterior decoration of public monuments by reason of its little expansion and contraction by changes of temperature and its durability, in these respects being superior to ceramic bodies. He also claims for

F. Gillet.

Flandrin.

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it the advantage of being obtainable in large blocks, giving broader surfaces than are readily made in pottery. It is these advantages, in the estimation of M. Gillet, that led him to seek to obtain a full palette of ceramic colors suitable to use upon this material, in the hope that decorative artists might here find the means of giving, in a degree at least, "immortality to their works." He claims that with the four palettes he has found it is possible to execute all styles of paintings. One is suited to imitations of fresco paintings; the second to oil paintings; the third to "*peinture sous couverte;*" and the fourth to the style of *aquarelle.*

Enamels on lava.

RIGAL & SANEJOUAND.

Rigal & Sanejouand.

This firm is the manufacturer and exhibitor of fine *faïence.* The works are at Clairefontaine, and were founded in 1802 by M. Étienne, for the production of the kind of *faïence* then called "*terre de pipe,*" or "earthenware" in English. In 1853 the extent of the business was greatly increased by the introduction of a popular style of fancy *faïence* of Nankin blue shade. Since 1862 the development has been rapid. Six large coal-burning furnaces have been constructed, and the works now turn out 1,500 tons annually of various products, which may be classed in five groups.

Founded by Étienne in 1802.

Product.

1. White *faïence* ("*faïences blanches*"), called in France "*porcelain opaque;*" in England, stone china. This is either plain or decorated by transfer or by hand-painting. It comprises table services and toilet sets chiefly.

White *faïence.*

2. Nankin *faïence,* chiefly in mugs, coffee cups, milk jugs, and water jugs.

Nankin *faïence.*

3. Green *faïence* for dessert services. This green color is due to a green glaze or enamel flowing over a surface in relief, generally leaves, grape leaves, etc., with which we are all familiar. They are made at this establishment in large quantities and at an extremely moderate price, and are largely exported.

Green *faïence.*

4. The fourth group comprises "*faïences majoliques,*" ivory pastes, etc. These are generally decorated in many colors and in relief enamels. It is claimed for Clairefontaine that the works were the first to introduce this ware for common use in services.

Faïence majolica, etc.

5. The fifth group comprises the variety known as "*faïences lithophaniques*" or "*émail ombrant,*" shaded enamel, in which the design is produced by first sinking it below the surface of the body and then filling it with a limpid enamel more or less deeply colored. The lights and shadows depend upon the depth or thickness of this coating. The

Faïence lithophanique.

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FRANCE.

agent of this establishment is the firm of Ferdinand Bing & Co., New York.

Vieillard & Co.

VIEILLARD & CO

Choisy-le-Roi enamels.

This firm, of Bordeaux, exhibited enamels in the style of *Choisy-le-Roi*. They have similar ruby-red blues and the *craquele* ground. Their vases and jars for decorative purposes are mounted in Japanese style on black carved stands, ebonized. They also make seats in black ebonized wood, in Chinese style.

Reproductions of Moustiers *faïence*.

The same firm presents dinner services in *faïence*, a reproduction of the famous Moustiers *faïence*, printed in blue, 122 pieces for 120 francs.

A. Thomas.

A. THOMAS,

Faïence bodies for decoration.

Of St. Denis, near Paris, exhibited an assortment of large vases and other ware in white porcelain, ready for decorators. This porcelain is made in great quantity, and is burned with soft French coal. So also a great variety of objects are made in *faïence* body, purely for decoration, and are sold in the biscuit state, ready for the painter.

One of the large porcelain vases stands 6 feet or more high. The body was molded in three pieces.

Sazerat.

SAZERAT,

Limoges plaques and enamels.

Of Limoges, makes plaques for enameling and decorating. He produces, also, imitations of Limoges enamels and enamels on copper in the old style. They supply the trade alone, and produce cheap or low-priced goods. They exhibited some specimens of coarsely executed *pâte-sur-pâte* decoration on *jardinières* of celadon-green and on toilet sets. They

Cheap fancy articles in *faïence*.

manufacture also a great variety of low-priced fancy articles, such as jewel and trinket boxes, in *faïence*, mounted, and flower pots and coffee and tea sets. A full coffee set for twelve persons is sold for 45 francs, 10 per cent. off.

O. Milet & C. Massier.

OPAT MILET & CLÉMENT-MASSIER.

Vases and bottles in peculiar colors.

This firm, established at Sèvres, exhibited some interesting examples of *faïence*, such as vases and pilgrim bottles, in a variety of pecular colors, obtained by enamels of their own mixing, chiefly blues and greens with yellow, and in some pieces all these colors were combined and lay in streaks and mottled mixtures, produced in part by the action of the fire. They also displayed some paintings in white slip on *faïence*, and some well-painted plaques of large size.

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CHAMPION.

FRANCE.

A. Champion.

This manufacturer of art *faïence* in Paris exhibited a variety of vases with designs in relief, chiefly in the Japanese style, with *émail ombrant.* The glazes were light and dark green, and produced some very fine effects by leaving the high lights standing up through them while they flowed deeper and darker into the depressions. The maker has a specialty of old Japanese designs, with the grotesque forms and panels such as are found on antique Oriental bronzes. He also exhibited some beautifully painted plaques, mounted in ebony frames.

Vases in Japanese style; *émail ombrant.*

Lustered ware.—J. Brianchon.

Lustered ware: J. Brianchon.

The nacreous porcelain of Brianchon, patented in many countries and in the United States, is well known to visitors to the Expositions at Vienna and Philadelphia. The writer, in reporting upon the display at Vienna, gave the following description, which is equally applicable to the Paris exhibit:

Nacreous porcelain.

"This exhibitor confined his display to a variety of specimens of ornamental objects, covered with a very brilliant pearly or nacreous glaze, semi-metallic in appearance, and, to the eye of a chemist, evidently due to the partial reduction of oxides in the glaze to a metallic state. There is a great variety of tints, from pearly white to a rose-pink; and some of the objects, such as shells, where the iridescent surface is peculiarly fitting, are very pleasing to the eye.

Pearly nacreous glaze.

"This is a modification of an ancient art which was long kept a secret. Its revival in France is due to M. Brianchon, who has succeeded admirably, making his pieces with more certainty and brilliancy than the old masters of the secret could attain. The early invention is attributed to the celebrated maestro, Georgio Andreoli, whose lustered wares are so highly prized by collectors. The purple or silver-lustered ware of Staffordshire is similar. The process was introduced there in Wedgwood's time, but has never made great progress. M. Brianchon's process consists in making enamels of nitrate of bismuth, iron, uranium, nickel, or cobalt, and adding a reducing agent, such as resin or essential oils. Objects of this nature have also been made at the Royal Porcelain Works, Worcester, and by the Beleek Company in Ireland."

Georgio Andreoli.

Brianchon's patents were taken out in 1867, since which he complains that by reason of the full description of his methods given to the world he has enjoyed but a fraction of the benefit which was due to him. His manufacture is carried on in Paris, and he employs some 50 or 60 persons, who receive from 5 to 10 francs a day, according to their skill.

Palissy ware.—Pull.

Copies of Palissy ware: G. Pull.

Pull's renowned copies of the ware of Bernard Palissy were not absent from the display of French ceramics. They are,

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FRANCE.

Reproductions of Palissy ware.

to all intents and purposes, as good as the originals. The thick, highly-glazed ware of this description made in England and on the Continent gives a very different impression than does this light, thin, and strong body, more like metal or *papier maché* than dense, heavy pottery. The colors are rich and harmonious, and closely follow the originals,

G. Pull.

which M. Pull is fortunate in having so accessible, and in fully appreciating. The large panel he has made, known as "*La Ceramique*," measures $2^{m}.70 \times 1^{m}.90$, and yet it is so light that the artist can carry it.

He makes only a small number of pieces, and dispenses with assistants or workmen. All are made by his own hands, and he alone prepares the enamels and fires the work. The prices are, of necessity, high. Most of the objects shown have been purchased by museums and connoisseurs.

Photographs on porcelain.

Photographs on porcelain.

Charbonnier Frères.

The exhibit of Charbonnier Frères, Longchamp (Côte-d'Or), of *faïence* and porcelain possessed especial interest by reason of the number and size of photographic impressions

Tiles and plaques, with copies of old engravings.

on tiles and plaques, under glaze, and burned in at a very high temperature, said to be not less than 2,000 degrees. Some of the copies of old engravings were very clear and neatly executed, the white and black being cleanly defined without blurring or running or "smuttiness." Other colors than black can be used, such as blue and red. It was claimed that the pictures shown had not been "touched up." The largest piece was 12 by 16 inches. The proprietors offer to produce such pictures at 4 francs the square decimeter. The process is patented in France and other countries.

Soft-porcelain paintings.

Soft-porcelain paintings.

E. & C. Lévy

Pâte-tendre vases.

E. & C. Lévy made a choice exhibition of *pâte-tendre* vases, mounted with gilt bases and handles. One large pair, standing nearly 3 feet high, is beautifully decorated with paintings. The first represents the Dukes of Northumberland and of Suffolk asking Lady Jane Grey to accept the crown, and the second the jealously of Lord Darnley. There were many delicately executed Watteau paintings of exquisite finish upon smaller vases.

Leon Barreau.

Leon Barreau exhibited a variety of decorative objects in

Imitations of old Sèvres.

pâte tendre, such as vases, plaques, and cups, and imitations of old Sèvres, marked with the Sèvres mark and B. B. The paintings are exquisite, and are well sunk into and incorporated with the glaze and body. The artists are Labouin and

Labouin. Poiterin.

Poiterin. These pieces have been subjected to the fire four

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times—twice for the paste and ground color, once for the painting, and once for gilding.

Paintings on faïence.

Paintings on *faïence.*

Among the numerous examples of underglaze painting on *faïence* we note those of Bouquet (Michel), ceramic artist, Paris, who paints upon a stanniferous enamel and burns in the colors at a high heat—*grand feu*—in the manner of the artists in Italian majolica of the fifteenth and sixteenth centuries and of the *faïences* of Rouen, Nevers, and Moustiers.

Michel Bouquet. Underglaze painting.

Henri Béziat exhibited *faïence de Quimper* paintings upon enamel and burned in *grand feu*. This house was founded in 1685 by Bosquet, of Marseilles, and was continued by Pierre Caussy, of Rouen. The pieces are very light and strong. The enamel and the designs are burned at one firing.

Henri Béziat; *faïence de Quimper.* House founded in 1685.

Charles Houry exhibited a variety of decorated *faïence*, soft glaze, like the Havilands. One of the plaques is 4 feet long and 1 foot wide, representing a group of chickens life-size. There are many landscapes and pilgrim bottles, with boldly painted decoration.

Charles Houry.

French imitations of old china.

Imitations of old china.

Among the many *fabriques* now devoted to the production of imitations of old and rare china we cannot omit to mention that of E. Clauss, devoted specially to the reproduction of the rarest and choicest examples of China and Japan, as well as old Sèvres and old Saxon. These are excellent counterfeits, and might deceive good judges. The Japanese specimens are modeled from examples in the museums, and are not all marked. They have a very ancient appearance, and the rough bottoms are actually browned and aged by artificial means. The pieces are small and large. I was assured that 10,000 francs' worth had been sold during the Exposition to the Japanese, to be taken to Japan. It suggests the inquiry whether they will not be resold to Europeans, one by one, as most precious rarities.

E. Clauss.

Copies of "Henri-Deux."

Copies of *Henri Deux.*

Boulenger, of the *Faïencerie de Choisy-le-Roi*, founded in 1804, exhibited, besides a great variety of *faïence* and enameled ware, copies of the famous *faïence d'Oiron*, or Henri-Deux ware, having all the appearance of the originals.

H. Boulenger.

Many of the vases made at this establishment are copies by molding from ancient Japanese bronzes. This is a fa-

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FRANCE.

Copies of Japanese bronzes.

vorite source of new designs for the French potters. Most of the old bronzes are easily molded, and consequently give little trouble in securing the matrices for shaping the clay. On some of the *faïence* a peculiar surface like shagreen has been obtained by covering the body with small points of enamel.

The copies of "Henri-Deux" ware shown by the Mintons in the British section have already been noticed.

Porcelain flowers.

Porcelain flowers.

The manufacturers and exhibitors of porcelain flowers were numerous, and their products are beautiful and more natural than would be supposed possible with vitreous materials.

Veuve Pinot.

Madame the widow Pinot was one of the exhibitors, who showed quantities of beautiful chrysanthemums and marguerites, besides whole sets of ornaments, pins, ear-rings, crosses, wreaths, and frames for pictures. The forms and colors are excellent.

F. Woodcock.

F. Woodcock, Paris, made a similar exhibit, but chiefly of bouquets, camellias, roses, and carnations, with pins attached, and designed especially for head ornaments. They certainly have the advantage of being brilliant and imperishable.

P. Dartout.

P. Dartout is another successful manufacturer of beautiful flowers in porcelain. Many of these smaller flowers are mounted on velvet bands for bracelets or neck ornaments. Bouquets for the table or mantle are also successfully made.

Souchet & Co.

Souchet et Cie.—This firm displayed flowers in enamel colors of very choice and superior make, chiefly white lilacs and orange blossoms, extremely natural in appearance.

School of Fine Arts, Limoges.

School of Fine Arts applied to Industry, Limoges.

The municipality of Limoges founded, in the year 1868, a school for giving gratuitous instruction in art applied to industry. Four hundred and fifty young persons receive instruction—250 young men and 200 young women.

Atelier d'Application. Exhibit.

The *Atelier d'Application* sent a very interesting display of the work of the scholars of the school, consisting of plates, plaques, cups, and saucers, in a great variety of styles and designs. There were samples of work in *pâte-sur-pâte* upon plates and plaques.

Prizes.

At this school prizes are given annually to the best scholars or those who produce the best original designs.

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Chemical porcelain ware.

Chemical porcelain.

Of ware for the use of chemists and for culinary purposes Veuve Gosse, of Bayeux (Calvados), is one of the principal exhibitors. Her chemical ware is shown in great variety, and is very cheap. Covered crucibles, for example, are sold in the biscuit or unglazed state from 25 centimes to 4 francs, the height or size ranging from 25 millimeters to 280; porcelain capsules 27 millimeters in diameter for 15 centimes, up to 4 francs for those 250 millimeters in diameter. The following directions are given for using the Bayeux porcelain on the fire:

Veuve Gosse.

Hard china for cooking purposes.

China cooking-vessels.

(Directions for using.)

Whatever may be the quality of the china ware manufactured at Bayeux, its utility will be readily appreciated by those using it for cooking purposes if they are careful to observe the following precautions:

Directions for using.

Care should be taken to fill it at first with lukewarm water, so that it may become gradually heated. When it is to be placed upon a grating at a distance above the flames it is not necessary that it should be full of water, as the gradual heat will be sufficient to warm it. Once being heated in this manner it will bear any amount of fire. In cooking eggs in it, for example, care should be taken that the butter placed in the dish is entirely melted before placing it upon the fire, and that the melted butter completely covers the bottom of the plate. When taking it off the fire care must be had not to place it directly upon any cold or damp substance. It may be brought directly in contact with gas or a wood fire, but it must never be placed in direct contact with a coal fire. It may be placed upon stoves or in ovens, but always with the precaution of a gradual warming beforehand.

BOCH FRÈRES ET CIE.

Boch Frères & Co.

By the courtesy of M. L. Pelletier, the director of this establishment, I am able to give some notes upon the extent of the production and the nature of the tiles. The tiles are far superior to the soft, half-burned terra-cotta bodies which have been so extensively used in times past and are still made in Spain and other countries, but more especially for wall decorations than for pavements. The tiles of Boch Frères are hard and durable, of pleasing colors, and are burned at a great heat. They are made as large as 170 to 190 millimeters square.

L. Pelletier.

Superior hard tiles.

Production.

The production of the establishment at Lourroil, near Mauboge (Nord), has become enormous, equal to 400 square meters of surface a day. They are exported to Belgium, Holland, and the departments of the north, to Pas-de-Calais and the Somme; also to England, Algiers, Egypt, Brazil,

Exportations.

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FRANCE.

and the United States—for example, in Trinity church, Boston, under the orders of the architect, Mr. Clark.

Boch Frères & Co.

Gold medal.

A gold medal was awarded.

Kaolin and feldspar of Saint-Yrieix.

The materials for French porcelain are obtained largely from the quarries of Saint-Yrieix (Haute-Vienne). C. Denuelle exhibits porcelain materials obtained from his quarries and ground in the mills of Chevrier, "*Les Usines du Chevrier*," situated upon the Loire, 1,200 yards from the railway station at Saint-Yrieix. These mills are run by four water-wheels and are the only mills in the center of the kaolin region. They receive their supplies—

Quaries of Saint-Yrieix. C. Denuelle.

Quaries of Verrille;

1. From the quarries of Verrille, yielding hard feldspars for enamel; ordinary feldspar for paste; lamellar fusible feldspar suitable for the manufacture of porcelain buttons; and the pegmatites used in the manufacture of superior porcelain pastes. The national manufactory of Sèvres is said to have obtained its enamel from this quarry.

Of Bourdoux;

2. From the quarries called Bourdoux, where there are three openings, from which M. Denuelle obtains kaolins of all varieties and quartzose-feldspathic sand.

Of Vigen.

3. From the Vigen quarry, yielding feldspar suitable for enameling purposes and for pastes.

All grades of porcelain materials.

It is claimed for these quarries by M. Denuelle that they enable him to supply in quantity all grades of porcelain materials suited to the needs of porcelain manufacturers, from the makers of telegraph insulators to the finest pieces of ware, and also suited to the wants of manufacturers of *faïence* and of glass and art tiles.

Production.

The daily production of these mills is 8,000 to 9,000 kilograms, and can be carried to 12,000 kilograms.

Kaolin of Quimper.

Kaolin of Quimper.

M. Morvan.

M. Morvan is the exhibitor of kaolin from his quarries at Arles (*Bouches-du-Rhône*), near the village of Quimper. The extent of the outcrop at the surface is 20 yards or more in length, the breadth 2 meters, and the depth is not known.

Kaolin.

Coal.

The surrounding country is underlaid by coal. This, with other advantages and the proximity of the sea, presents exceptional advantages, in the estimation of M. Morvan, for the establishment of the manufacture of porcelain for exportation.

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BELGIUM.

LIST OF EXHIBITORS.

Class 20; Ceramics.

BOCH FRÈRES, *à la Louvière.* *Faïence,* vases, tables, plaques, like Delft ware. Medal, Paris, 1855; medal, London, 1862; silver medal, Paris, 1867.

COUROUBLE (Mlle. YVONNE), 166 *Avenue de Cortenbergh, à Bruxelles.* *Faïence* plaques.

DAUGE (FRANS), *Rue de Suède,* 49, *à St. Gilles, lez-Bruxelles.* Plates—woman's head, shepherd; vases, etc. Medal, Vienna, 1873.

DAVIGNON (Mme. NOÉMI, née HENRAD), 30 *Rue des Écoles, à Verviers.* Artistic porcelains and *faïence* painted from nature; vases and *jardinière* for ornamenting fire-place; plates, etc.

DE KONINCK (HENRI ET JOSEPH, FRÈRES), *Rue de la Station, à Diest.* *jardinière* for garden; rustic style; collection of rustic flower pots; vases; baskets.

DELIN (PROSP.), 77 *Rue de Comte de Flandre, Molemb, St. Jean.* Painted *faïence*; plate—Autumn, Birth of Venus, from Rubens, etc.

DE MOL (ADOLPHE), 8 *Rue Godecharles, à Ixelles, lez-Bruxelles.* Vase, Louis XVI; plates decorated with flowers and figures. Medal, London, 1862; Paris, 1867; Vienna, 1873.

GASPAROLI (Mlle. MARIA), 153 *Rue du Trône, à Bruxelles.* Painted *faïence.*

GILBERT (Mlle. JENNY), 29 *Rue de Toulouse, à Bruxelles.* Five plates.

LEFEVER, 68 *Rue Josaphat, à Schaerbeek, lez-Bruxelles.*

MALTBY (Mlle. EVA), 92 *Rue du Cornet, à Etterbeek, lez-Bruxelles.* *Faïence* and porcelains.

MARINUS (Mlle. ESTELLE). 423 *Rue des Palais, à Laeken, lez-Bruxelles.* Painted porcelains; plates; portrait of the Queen of Italy.

PERRIGNON DE FRÉNOY (Mlle. ALINE), 31 *Rue Godecharles, à Ixelles, lez-Bruxelles.* Plaques, plates, and other porcelains.

TOURTEAU (EDOUARD), 7 *Rue d'Orléans, à Ixelles-Bruxelles.* *Faïence;* plaques; arabesque vases. Medal, Vienna, 1873; medal, Philadelphia, 1876.

VAN IMMERSEEL (Mlle. HERMINIE), 53 *Rue des Palais, à Schaerbeek, lez-Bruxelles.* *Faïence;* porcelain.

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AUSTRIA.

Imperial Porcelain Works, Vienna.

Imperial Porcelain Works, Vienna.

Established in 1717, by Blanquièr.

The manufacture of porcelain was established in Vienna in 1717, by Blanquièr. In 1847 the works were purchased by the Empress Maria Theresa for 45,000 florins, and Blanquièr was made director. In 1750 40 men were employed; in 1761, 140; in 1770, 200; and in the year 1780, 320. In

History.

the period from 1760 to 1790, under the sculptor Niedermayer, the production of figures and groups was most developed. More attention was then given to decoration of the ware by painting, under the direction of the chemist

Leithner.

Leithner, who produced the beautiful blue color known by his name, the reddish brown, and the superb gilding.

Artists.

The first artists of the day were engaged to furnish sketches; and among the artists we find the names of Watteau, Sancret, Boucher, and Angelica Kauffmann. In 1827

Niedermayer.

Director Niedermayer died, and the establishment gradually declined in importance until 1864, when the Reichsrath refused further sums for its maintenance and stopped operations. The models were destroyed, and the buildings were turned into an imperial cigar factory.

Private works in 1702.

Private porcelain works, *zum Eisgrübl*, had been established in 1702, and this firm came into possession of most of the stock on hand in the imperial works, and has since continued the manufacture on a smaller scale.

List of exhibitors.

LIST OF EXHIBITORS.

Class 20; Ceramics.

DZIEDUSZYCKI (Comte W.), *Léopolis, Galicie.* Pottery.

EICHLER (E.), *Dux et Schelton, Bohême.* Pottery; imitations of majolica.

ERNDT (B.), *Vienne.* *Faïence* stoves and samples of paving tiles.

FALB (C.), *Vienne.* Decorative porcelain.

FEITEL (T.), *Vienne.* Objects in *terre cuite* and majolica.

FISCHER ET MIEG, *Pirkenhammer, Bohême.* Decorative and gilded porcelain.

FÖTINGER (J.), *Gmunden, Haute Autriche.* Toys for children; culinary pottery.

HAAS ET CZJZEK, *Schlaggenwald et Chodau, Bohême.* Coffee and tea service; toilet sets.

KLAMMERTH (A.), *Znaim, Moravie.* Majolica; *faïence;* stone ware.

KLAMMERTH (A.), *Znaim, Moravie.* Culinary pottery.

LEDERER ET NESSENYI, *Floridsdorf, Basse Autriche.* Porcelain bricks; objects in stone ware and *terre cuite.*

LITTROW-BISCHOFF (A. DE), *Vienne.* Imitation antique vase.

MILLER (DE) FRÈRES ET HOCHSTETTER (C.), *Hruschau, Silésie.* Stone ware and *terre cuite.*

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PLATE 7.

(Graduation on Solon.)

[Page 178, vol. IV.]

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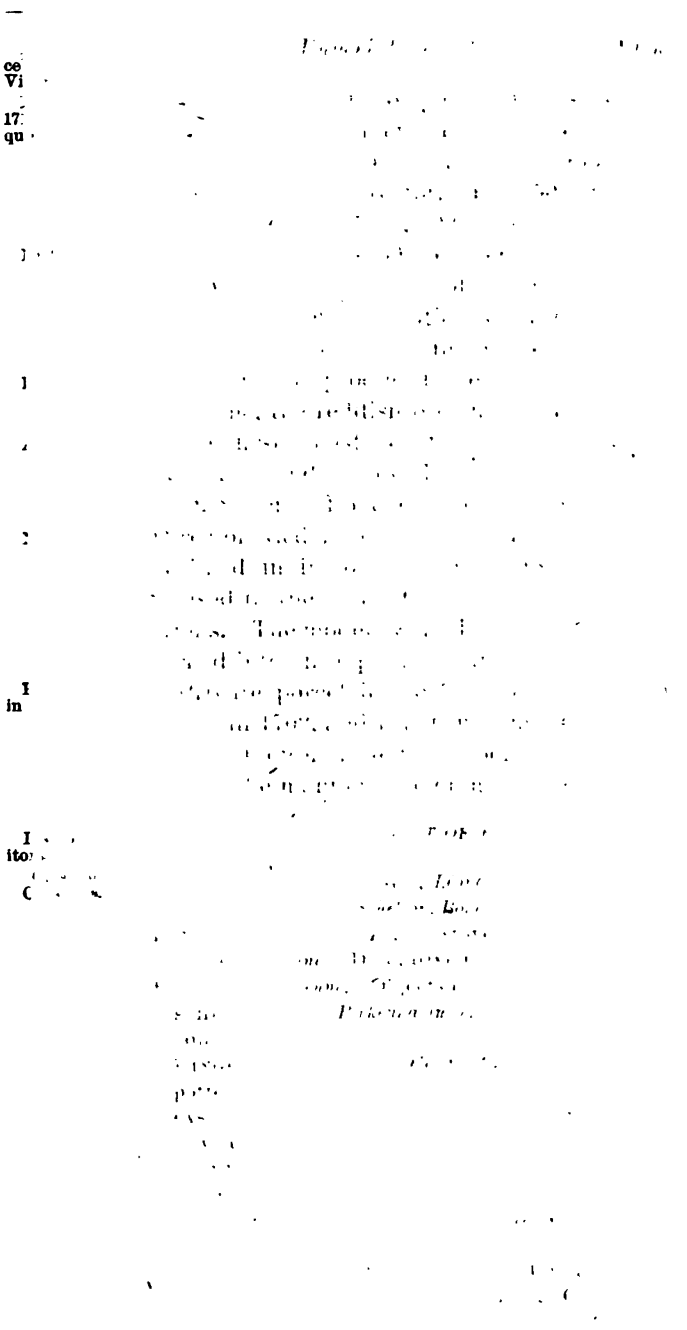

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PLATE 7.

GERMANY.
(Graſito tile by Solon.)

[Page 178, vol. III.]

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AUSTRIA.

List of exhibitors.

PECHAR (J.), *Teplitz, Bohême.* Mosaic paving blocks.
PODUSCHKA (W.), *Krummunsebaum, Basse Autriche.* Porcelain pottery.
RÄDLER ET PILZ, *Vienne.* Decorative porcelain.
SCHÜTZ ET FRÈRES, *Vienne.* Pitchers and plates.
SLOWAK (F.) AÎNÉ, *Znaim, Moravie.* Artistic majolica and *faïence*, style antique.
SOMMERSCHUH (W.-J.), *Prague, Bohême.* Stove chimney, enameled bricks, and pictures.
STEINER (M.), *Vienne.* *Terre-cuite* pipes.
TSCHINKEL (A.), *Eichwald, Bohême.* Products in siderolithe and porcelain; household pottery.
WEISKOPF (P.), *Morchenstern, Bohême.* Colors and enamels for majolica; enameled objects.
WIENERBERGER (Société de la Briqueterie de Wienerberg et Société de Constructions), *Vienne.* Bricks, statues, and other objects in *terre cuite.*
WUDIA (F.), *Graz, Styrie.* Mantel and fountain in majolica.
ZASCHE (J.), *Vienne.* Painting on porcelain; enamels.

HUNGARY.

HUNGARY.

Tsolnay Vilmos.

Zsolnay Vilmos, at Pécs (Funfkirchen), Hungary, delighted the eyes of connoisseurs and collectors of beautiful pottery and *faïence* by his exhibit of *grand-feu faïence*, with superb underglaze decoration. The designs were moresque or Persian in character, and were chiefly remarkable for the vivid blues, reds, and greens upon a delicate cream-colored base, and thoroughly incorporated with a very hard, lustrous glaze, evidently feldspathic. This ware evidently has passed through a very high degree of heat. The plaques, *cruches*, and cups are exquisite in coloring and effect, and the prices are moderate.

Grand-feu faïence.

Remarkable colors and quality.

Reproduction of ancient pottery.

The same exhibit contained reproductions in grafito of ancient or mediæval pottery found in some of the Hungarian tombs. The designs are mostly geometrical, consisting of lines and triangular figures with dots.

List of exhibitors.

LIST OF EXHIBITORS.

Class 20; Ceramics.

FISCHER (I.), *Buda-Pesth, Hongrie.* *Faïence*, majolica.
FISCHER (S.), *Herend, Hongrie.* Porcelain.
FISCHER MAURICE DE FARKASHÁZA, *Tata, Hongrie.* Porcelain.
HÜTTL (T.), *Buda-Pesth, Hongrie.* Porcelain.
LÁNG (M.), *Buda-Pesth, Hongrie.* Porcelain.
LAY (F.), *Zágráb, Croatie.* *Faïence.*
SÁRKÖZY (É.), *Szegszárd, Hongrie.* Mosaic pavement.
SCHMIDT LUDMILLA, *Selmeczbánya, Hongrie.* Pipes.
SOCIÉTÉ DE MINES ET BRIQUES, *Buda-Pesth, Hongrie.* Bricks.
STIASNY (É.), *Körmöczbánya, Hongrie.* Mosaic pavement.
TAKÁCS (V.), *Zólyom Hongrie.* Mosaic pavement.
VERES (F.) ET FISCHER (V.), *Kolozsvár, Transylvanie.* Colored porcelain.
ZSOLNAY (G.), *Pécs, Hongrie.* *Faïence*, porcelain, and clay.

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List of exhibitors.

Class 20; Ceramics.

ITALY.

NAMES OF EXHIBITORS.

AGRESTI ET FRÈRES (M.), *Florence.* Objects in enamel on *terre d'Impruneta*, imitation of Della Robbia.

BATTAGLI (G.), *Naples.* Candelabra in *faïence.*

BENUCCI ET LATTI, *Pesaro.* Vases and ornamental dishes, imitation of fifteenth century.

BERTANZI (G.), *Umbertide, Pérouse.* Imitation of Etruscan vases.

CASTELLANI (T.), *Rome.* Collection of *faïence*, reproduction of ancient Italian and Oriental wares.

DELANGE (H.), *Naples.* Objects in fictile art.

DEVERS (Chevalier J., Professeur), *Turin.* Fictile objects, modern and in imitation of the antique, artistic and useful.

FARINA (A.) ET FILS, *Faenza.* Works in *faïence;* medallion on the Italian façade, Rue des Nations.

FERNIANI (Comte A.), *Faenza.* *Faïence* vases; bas-reliefs, etc.; medallions in the vestibule of the Italian section.

GINORI LISCI (Marquis L.), *Florence.* White and colored porcelains for common and telegraphic, chemical, etc., purposes; artistic porcelains; artistic and ornamental *faïences.*

GIUSTINIANI (M.), *Naples.* Large *faïence* vases, imitation of fifteenth century; round table in *faïence;* vases, cups, seats, dishes, in *faïence;* imitation of Etruscan and Greco-Sicilian costumes.

LEONS (A.), *Catane.* Statuettes in *terre cuite*, colored, and representing Sicilian costumes.

MELICHI (T.), *Venise.* Fictile work, ornaments, consoles, and small figures.

MINGHETTI (A.) ET FILS, *Bologna.* Bas-relief medallions; vases, bottles, amphora, dishes, consoles, groups.

PALME (J. et C.), *Pisa.* Pottery.

PEPI (B.), *Sienne.* Fictile medallions, imitation of Lucca della Robbia.

RUBBIANI (C.), *Sassuole, Modène.* *Faïence.*

SCAPPINI (A.), *Corneto Tarquinia, Rome.* Vases in *terre cuite*, imitation of Etruscan.

SPINACI (J.), *Gubbio.* Vases, amphora, ornamental and colored medallions, with metallic colors.

TANFANI (C.), *Rome.* Vases in *terre cuite*, varnish colored and enameled, Etruscan style.

TORELLI (J.), *Florence.* Groups, statuettes, mosaic bas-reliefs in biscuit.

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PLATE.

ITALY.
(Graffito title by Solon.)

[Page 180, vol. III.]

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List of
itors.

Class 20;
Ceramics

PLATE 8.

ITALY.
(Grafito tile by Solon.)

[Page 180, vol. III.]

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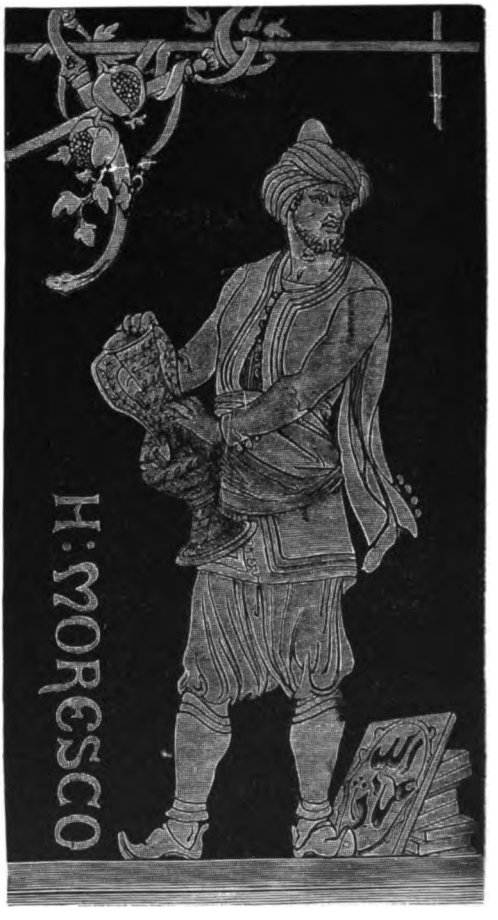
PLATE 9.



MOROCCO.
(Grafito tile by Solon.)

[Page 181. vol. III.]

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exhib-

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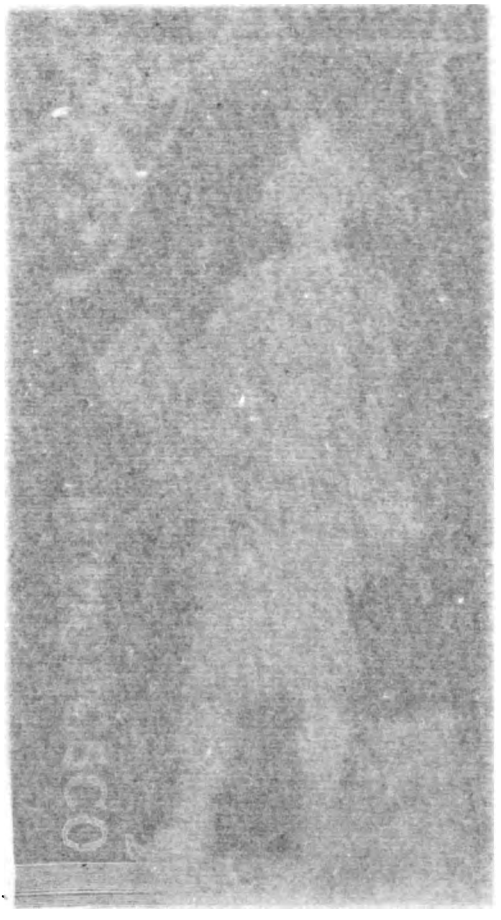

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List of exhibitors. Class 20; Ceramics.

SPAIN.

NAMES OF EXHIBITORS.

ALMAZAN Y BRABO (G.), *Almazan, Soria.* Glazed stew-pans.

ALVAREZ (D.), *Logroño, Fuenmayor.* Fictile objects.

ARRIBAS (F.), *Soria.* Pots, pans, and lids in earthenware.

AULEY-GARCIA (J.), *Almeria.* Household objects in *terre cuite;* jars for cooling water.

BATLLE Y SOLER (F.), *Gerona, Breda de San-Salvador.* Clay pottery.

BAUZÁ (F.), *Palma, Baléares.* Bricks of different forms and colors.

CAMACHO (F.), *Andugar, Jæn.* Pottery.

COMMISSION DE LA PROVINCE DE CÁCERES (La). Pottery of Trujillo, Plasencia, and Arroyo del Puerco.

COMMISSION PROVINCIALE DE REDONDELA Y BARRIOS, *Pontrevedra.* Ordinary *faïence* of the province.

CORDERO (H.), *Huelva.* Water pipes in baked clay; building and paving bricks.

FAR Y NADAL (B.), *Soller, Baléares.* *Faïence* tiles; paving blocks of crude clay.

GALBAN Y CORDERO (P.), *Séville.* *Faïence* flower stands.

GARZON (J.), *Andujar, Jæn.* Pottery.

LOPEZ (J.-R.), *Grenada.* Stew-pans and pots in two parts; steam-cooking pots in three parts.

LOPZ-ROBERTE (F.), *Lorca, Murcie.* Clay pitchers.

LUQUE BLANCO (R.), *Cordoue.* Objects in baked clay.

MALLAFRÉ (O.). *Selva, Tarragone.* Pottery.

MARIJUAN (J.), *Santo-Domingo, Logroño.* Divers objects in clay.

MESADA (J.), *Teruel.* Building bricks, flags, tiles, water pipes, glazed and unglazed.

MOLINA (J.), *Ségovie.* Files, flags, brick, and lime.

MORALES GIMENEZ (M.), *Grenade.* Pitchers, jars, and large varnished dishes.

MUNICIPALITÉ DE HIGUERUELA, *Albacete.*. Pottery.

MUNICIPALITÉ DE LUMBIER, *Navarre.* Pots; stew-pans; *chocolatières;* covers; small pitchers; money-boxes.

MUNICIPALITÉ DE NAVARRETE,, *Logroño.* Pottery.

MUÑOZ (M.), *Andujar, Jæn.* Pottery.

ORTEGA Y GARCIA (A.), *Almazan, Soria.* Glazed stew-pans.

ORTIZ GARCIA (P.), *Bailen, Jæn.* Pottery.

PADILLA (A.), *Andujar, Jæn.* Pottery.

PARDO MONTENEGRO (J.-M.), *Mondoñedo, Lugo.* Earthenware.

PARERA (A.), *Manacor, Baléares.* Bricks of divers forms and colors; paving blocks.

PASCUAL (E.), *Burgos.* Flower pots and flower stands, plain and colored; fine brick paving tiles.

PEREZ (J.), *Samos, Lugo.* Bricks; ordinary earthen pots; wine jars; water pipes.

PEREZ MONEO (A.), *Salamanque.* Tiles, bricks, and paving tiles.

PICAZO (A.-J.), *Huelva.* Caraffe of colored clay, Arabic style; vase, Renaissance style; flower pot.

PICKMAN Y CA., *Séville.* Chinese porcelain, opaque and transparent; glazed *faïence.*

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SPAIN.

List of exhibitors. Class 20; Ceramics.

POTIERS DE TERRE DE LA VILLE DE CHINCHILLA, *Albacete.* Pottery; specimens of material for the making of crucibles and fine brick paving tiles.

RODRIGUEZ WALDO, *Alba de Tormes, Salamanque.* Glazed *faïence* and tiles.

SAMBOLA (F.), *Verdú, Lérida.* Pots in plastic clay.

SANCHEZ (A.), *Toledo.* Tray of ordinary green *faïence*; large jar; pottery.

SERRANO (J.), *Andujar, Jaen.* Pottery.

SOCIÉTÉ DE L'AGRICULTURE, DE L'INDUSTRIE, ET DU COMMERCE DE CASTELLON, *Alcora.* Wine vat; earthen tub for brandy; pots for conserves.

SOCIÉTÉ DE L'AGRICULTURE, DE L'INDUSTRIE, ET DU COMMERCE DE LUGO. Objects in earthenware.

SOCIÉTÉ DE L'AGRICULTURE, DE L'INDUSTRIE, ET DU COMMERCE DE PALENCIA. *Faïence.*

SOCIÉTÉ DE L'AGRICULTURE, DE L'INDUSTRIE, ET DU COMMERCE DE PAMPELUNE, *Navarre.* Pitchers of Tafalla; glazed pots and stewpans of Lumbier; small vats; pitcher and jar of fine glazed earthen ware of Estella.

TRIANES (J.-A.), *Huelva, Aljaraque.* Paving tiles, bricks, tiles, and water pipes.

VACAS (P.), *Andujar, Jaen.* Pottery.

VALLEJO (L.), *Andujar, Jaen.* Pottery.

VARGAS Y MAYORGA (M.), *Ségovie* Specimens of ware and kaolin.

VILCHES (M.) (Ve. TAPIA), *Jaen.* Earthenware and collection of measures.

VISIER Y BENITO, *Cuença.* Earthenware.

ZALDIVAR-TOFÉ (A.), *Navarrete, Logroño.* Earthenware.

JIMENEZ DE LA SLAVE (L.), *Toledo.* Shield of Spain in blocks of *faïence.*

PORTUGAL.

PORTUGAL.

NAMES OF EXHIBITORS.

List of exhibitors. Class 20; Ceramics.

AMARO (J. M. G.), *Figueira da Foz, Coimbra.* Bricks, tiles, and different objects in clay.

BENTO (M.), *Leiria.* Cheap, ordinary pottery.

CAMPOLINI (M.), *Porto.* Small figure in *terra cuite*, representing different costumes in the neighborhood of Oporto.

CARLOTA (J. DE), *Leiria.* Ordinary pottery.

CASCO (J.), *Reguengos, Evora.* Wine jars.

CHAMBRE MUNICIPALE DE REDONDO, *Evora.* Ordinary pottery.

CHAMBRE MUNICIPALE DE CAMPO-MAIOR, *Campo-Maior, Portalegre.* Wine and olive-oil jars.

CIFKA (W.), *Lisbonne.* Collection of *faïence* belonging to King Alfonso II.

CIFKA (W.), *Lisbonne.* Large collection of *faïence*, imitation of the antique.

COELHO (F.), *Santarem, Torres-Novas.* Bricks and tiles.

COMMISSION CENTRALE, *Lisbonne.* Jars of Extremoz.

COMMISSION CENTRALE DE PORTO. Statuettes in *terre cuite*, representing national costumes.

COMMISSION DE FUNCHAL, *Île de Madère.* Statuettes in *terre cuite*, representing the costumes of the island of Madeira.

COMMISSION INDUSTRIELLE DE PORTO, *Aveiro. Faïence.*

COMMISSION INDUSTRIELLE DE PORTO, *Oliveira de Azemeio. Faïence.*

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PORTUGAL.

List of exhibitors in Class 20: Ceramics.

COMMISSION INDUSTRIELLE DE PORTO, *Villa-Verde, Braga.* Ordinary pottery.

COMPAGNIE CONSTANCIA, *Rue das Janellas-Verdes, Lisbonne. Faïence.*

COELHO (F.), *Santarem, Torres-Novas.* Bricks and tiles.

CORREIA (J.-L.), *Niza, Portalegre.* Ordinary pottery.

COSTA (A.-A. DA) ET CIE, *Villa Nova de Gaya, Porto.* Statuettes in *terre cuite*, representing the national costumes.

CUNHA (J.-A.), *Leiria. Faïence* of Caldas.

FABRIQUE DE SACAVEM (directeur, M. John-Stott Howort), *Sacavem, Lisbonne. Faïence.*

FERREIRA PINTO (M.-A.), *Porto. Faïence.*

LAMEGO (Ve), *Lisbonne. Faïence.*

LEIRIA (J.-P. DA CRUZ), *Lisbonne.* Statuettes in *terre cuite*, representing the national costumes.

LIZO (J.-F. DE SOUSA), *Leiria. Faïence* of Caldas.

LOBO (M.-F.), *Crato, Portalegre.* Ordinary pottery.

MALLATO (M.), *Crato, Portalegre.* Ordinary pottery.

MAFRA (M.-C. GOMES), *Leiria. Faïence* of Caldas.

MATTOS (J. DE), *Tondella, Vizeu.* Ordinary pottery.

MORAES (M.-G.), *Lisbonne.* Objects in *terre cuite.*

MUSÉE DES COLONIES, *Lisbonne.* Common pottery of Africa and Portuguese India.

OLIVEIRA (J.-R.), *Niza, Portalegre.* Ordinary pottery.

PIMENTÂO (A. DE AYRES), *Evora.* Ordinary cheap pottery, used by peasants.

PINTO BASTO (D. F.), *Llhavo, Aveiro.* Porcelains of the manufactory of Vista-Alegre.

ROVISCO (F.), *Crato, Portalegre.* Ordinary pottery.

SANTOS (J.-A. DOS), *Coimbra.* Pottery.

SILVA (S.-A.-P. DA), *Aveiro.* Earthen vase of Roman times.

SILVA ET SANTOS, *Porto.* Statuettes in *terre cuite*, representing national costumes.

SWITZERLAND.

SWITZERLAND.

List of exhibitors.

BODMER ET BIBER, *Seefeld, Zurich. Faïence* stoves.

EYER (C.), *Heimberg, Berne.* Majolica.

FABRIQUE DE POTERIES DE ZIEGLER, *Schaffouse.* Fire-place *faïence*, brown glazed, fine.

KÜNZI (B.), *Heimberg, Berne.* Artistic enameled ware; majolica, style Pompeiian.

MATHEY (A.-O.), *Neuchâtel.* Porcelain painting.

PERROTT (A. ET E.) MAYOR, *Genève.* Artistic *faïence*, hard baked in cressets, and in crude enamel; plates, dishes, friezes, vases, etc.

SCHENK-TRACHSEL (J.), *Heimberg, Berne.* Majolica.

NETHERLANDS.

NETHERLANDS.

List of exhibitors.

CLEMENS ET FILS (C.), *Gouda.* Amphora of *terre cuite*, style of the Renaissance.

SOCIÉTÉ CÉRAMIQUE (directeur-gérant, W. Vogelaar), *Maestricht, Wyck. Faïence.*

THOOFT (J.) (Maison Piccard et Cie), *Delft.* Fine *faïence.*

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SWEDEN.

Rörstrand, 1726. Gustafsberg, 1827.

The ceramic art as it exists to-day in Sweden is represented by the factories of porcelain and *faïence* at Rörstrand, which were founded in 1726, and at Gustafsberg, founded a century later, that is in 1827.

Höganäs.

Gustafsberg is situated about 20 kilometers to the east of the capital, on an island in the Baltic. There are also any number of brick and terra-cotta works at Höganäs, in Scania; also porcelain, stove, and pottery works of all grades.

Helsingfors.

The society of manufacturers of Rörstrand established in 1874 a branch establishment at Helsingfors, in Finland.

A factory at Malmo, founded lately, only worked during two years, that is, until 1875, when it ceased to exist.

Marieberg, founded 1758.

In a treatise, howsoever brief, mention is due to the manufactory of porcelains at Marieberg, near Stockholm, which was founded in 1758, and existed until 1788. The old *faïences* of Rörstrand and Marieberg, and, above all, the porcelains of the latter manufactory, are considered very rare, are eagerly sought after by amateurs, and bring the highest prices. At

Rörstrand and Gustafsberg.

Rörstrand, as at Gustafsberg, the manufacture comprises nearly all the products of the ceramic art, from the real feldspar crockery to the finest *faïence* work. The two factories are of about the same magnitude. They occupy about 1,000

Productions.

workmen, and their total production for the past few years amounts to from two millions to two and one-half millions of crowns. They sell the larger portion of their products in Sweden, but with Denmark, Norway, Russia, and other

Exports of majolica and parian.

countries, there is also an exportation trade of considerable extent in certain special kinds, such as the Rörstrand majolica, and Gustafsberg "parian."

Materials.

Of the raw materials used, the clay comes from the counties of Devonshire, Dorsetshire, and Cornwall, England; the silex from Denmark, island of Móen, and from the environs of Dieppe, France; quartz and feldspar from the archipelago of Stockholm; refractory clays from Höganäs and England.

Fuel.

The principal combustible used is English sea-coal.

The two manufactories have always kept in the front rank of discoveries and improvements, and at the great exhibitions in Sweden and abroad they have always merited and received first honors.

Höganäs.

The factory of Höganäs principally produces sewer pipes and pipes for like purposes, of a solid brown compact ap-

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SWEDEN.

pearance; also bricks, tiles, and other articles of hard clay. It is only here lately that the clay found in the neighborhood of Scania begins to be used in the manufacture of these articles. Höganäs.

The manufacture of porcelain (*faïence*) stoves is of considerable importance in Sweden, and indeed these stoves are almost entirely used for house-heating purposes. The tiles, ordinarily made with or without sand, of marly or ferruginous clay, have a covering of transparent lead, in color generally green or brown. At times the color becomes thin, leaving in view the natural yellow or whitish yellow of the clay. An opaque varnish is also used, which gives the effect of porcelain to the clay. *Faïence* stoves. Stove tiles.

Among the many marly clays used that coming from Upsala is recognized as the best. Clay of Upsal.

Between 1840 and 1850 M. Westman, stovemaker, of Stockholm, introduced many notable improvements, and succeeded in obtaining a covering of a beautiful color, and to-day these stoves have become famous for their beauty, durability, and finish of workmanship. This is principally the case in those manufactured by A. Kerlin, in Stockholm, and also of C. A. Petterson and B. H. Lundguen, of the same city; of A. Ringnér, at Gothenburg, and V. E. Ringnér, at Malmö; the manufactories of Örebro and Upsala and Rörstrand, which make stoves of white *faïence* with translucid covering. Westman, and other stove makers.

We have already spoken of Höganäs as making all kinds of ordinary pottery, and this is also done at Helsingborg, Orkarshamm, Gefle, and in several other localities. Ordinary pottery.

These *faïence* stoves of Sweden have already an excellent reputation, and are highly appreciated abroad. There are many places where the manufacture of drain pipes is carried on extensively, but the consumption is principally local.

The following statistics are from a list of 197 brick factories, in the year 1876. With a total number of 2,652 workmen, the production amounted to 2,000,000 crowns. The value of the stove factories and potteries in 1876 was estimated at 750,000 crowns, the number of workmen employed being 580, to which number must be added 676 master-workmen and stovemakers. Statistics.

SWEDEN AND NORWAY.

List of exhibitors, Class 20: Ceramics.

COMPAGNIE DE GUSTAFSBERG, *Stockholm.* Biscuit ware; porcelain; *faïence;* majolica; parian; *terre cuite;* decorative and architectural *faïence.*

COMPAGNIE DES HOUILLÈRES DE HÖGANÄS, *Höganäs. Terre cuite;* decorative and architectural pottery.

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SWEDEN.

List of exhibitors, Class 20: Ceramics.

COMPAGNIE DE RÖRSTRAND, *Stockholm*. Porcelain; *faïence;* majolica; parian; decorative and architectural *faïence.*

CHRISTIANA (FABRIQUE DE TERRE CUITE DE) (K.-E. Johnson), *Christiania.* Vases, cups, medallions, etc., in *terre cuite.*

OBJETS DE LOTERIE DE LA SOCIÉTÉ INDUSTRIELLE OUVRIÈRE DE CHRISTIANIA. Vase and flower pots in *terre cuite* of Pedersen, Christiania.

RUSSIA.

RUSSIA.

List of exhibitors, Class 20: Ceramics.

CYBULSKI (C.), *Tsmelew, Radom.* Pottery.

EGOROFF, *Paris.* Porcelain painting.

FARRIQUE DE FAÏENCES ARABIA, *Helsingfors, Finlande. Faïences.*

KLENIEWSKI (J.), *Opole, Lublin.* Brick tiles for stoves.

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PLATE 10.

CHINA.
(Grafito tile by Solon.)

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exhib
ss 20

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NAMES OF EXHIBITORS.

BEAZELEY (M.), *Amoy*. Vases, dishes, etc., in antique porcelain.
CHÜ PAO, *Shanghaï*. Porcelain.
CHWAN MEI, *Kiukiang*. Vases and other objects in porcelain.
DOUANES CHINOISES D'AMOY. Paving tiles, tiles, bricks, and pipes in *terre cuite;* common porcelain.
DOUANES CHINOISES DE CHEFOO. Objects in *terre cuite*.
DOUANES CHINOISES DE FOOCHOW. Porcelain.
DOUANES CHINOISES DE KIUKIANG. Vases and other objects in porcelain.
DOUANES CHINOISES DE NINGPO. Bricks, paving tiles, and tiles.
DOUANES CHINOISES DE PAKHOI. Vases.
DOUANES CHINOISES DE SWATOW. Objects in porcelain; common pottery.
FOW LOONG, *Canton*. Vases, etc., in porcelain.
GEPP ET DAVIS, *Canton*. Porcelain vases.
GLOVER (G.-B.), *Shanghaï*. Antique porcelain.
HU KWANG-YUNG, *Shanghaï*. Vases and other objects in antique porcelain.
KITCHING (F.-W.), *Foochow*. Porcelain idol.
KOPSCH (H.), *Kiukiang*. Vases and other objects in porcelain.
KWONG LI-CHENG, *Canton*. Porcelain vases.
MOUILLESAUX DE BERNIÈRES (A.), *Foochow*. Porcelain screen.
QUONG CHING-YONG, *Shanghaï*. Vases and other objects in antique porcelain.
SHÊNG TAOTAI, *Shanghaï*. Vases and other objects in antique porcelain.
SIMPSON (C.-L.), *Shanghaï*. Vases and other objects in antique porcelain.
TIEN PAO, *Shanghaï*. Vases and other objects in antique porcelain.
TURNER (W.-M.), *Shanghaï*. Vases and other objects in antique porcelain.
VRARD (L.) ET CIE., *Tientsin*. Objects in porcelain.
WONG PING-SING, *Foochow*. Vases of antique porcelain.
YÊH FÊN, *Tientsin*. Porcelain snuff-boxes and vase.
YUT SHING, *Canton*. Porcelain vases.

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List of exhibitors, Class 20: Ceramics.

JAPAN.

NAMES OF EXHIBITORS.

ABÉ (A.), *dep. of Ishikawa, prov. of Kaga.* Porcelain; flower vases, flower pots, coffee sets, *bonbonnières*, large bowls, perfume-burner, tea cups, etc.

AÇANO (Z.), *dep. of Aichi, prov. of Owari.* Cups in *nouri-shippo* ware (lacquered porcelain), with designs.

AKIYAMA (T.), *dep. of Aichi, prov. of Owari.* Porcelain; cigar-holding boxes; sugar bowls; flower vases; shelves; flower pots; coffee cups; bowls; pictures.

AUKI (T.), *dep. of Aichi, prov. of Owari.* *Faïence;* small bureaus; flower pots; tea-pots; perfume-burners.

AUTA (J.), *dep. of Miye, prov. of Ise.* *Faïence* tea-pots.

AUTA (M.), *Tokio.* Porcelain; flower vases; dishes and plates; milk jugs; tea-pots.

DATÉ (D.), *dep. of Miye, prov. of Ise.* *Faïence* tea-pots.

DATÉ (K.), *dep. of Miye, prov. of Ise.* *Faïence* tea-pots.

HAKOU-BOUTSOU-KIOKOU. Ancient porcelain and *faïence.*

HARA (H.), *dep. of Aichi, prov. of Owari.* Porcelain with *cloisonné* enamel; coffee cups; flower pots; pitchers.

HATTORI (T.), *Tokio.* *Faïence;* flower vases; perfume-burners; flower pots; covered bowls; small tea-pots; plates and dishes; pipes.

HIOTIYEN, *Tokio.* Porcelains made in different places and painted at Tokio; flower vases; paintings; lamp bodies; small boxes; covered basins; plates and dishes; card-receivers; coffee sets; Japanese tea sets; cups; water jugs; plaques for door panels; cuff buttons.

HIGOUTI (H.), *Tokio.* *Faïence;* basins; cigar-holders; flower vases; coffee services.

HORI (T.), *dep. of Miye, prov. of Ise.* Coffee services in *faïence.*

HOUZISHIMA (S.), *dep. of Aichi, prov. of Owari.* Porcelain; flower pots; cups.

IRIYAMA (K.), *dep. of Miye, prov. of Ise.* Coffee services in *faïence.*

ISHIKAWA-KEN-KANGUIÔ-JÔ (Manufacture de bronze et de porcelaine du département d'Ishikawa), *prov. de Kaga.* Porcelain; cigar stands; *bonbonnières;* flower vases.

ISHIMA (S.), *dep. of Miye, prov. of Ise.* *Faïence* tea-kettles.

ITÔ (H.), *dep. of Miye, prov. of Ise.* *Faïence* cigar-holders.

ITÔ (K.), *dep. of Miye, prov. of Ise.* *Faïence* tea-pots.

IWATA (S.), *dep. of Aichi, prov. of Owari.* Porcelain; flower vases; fruit plates; coffee sets.

KAKIMOTO (H.), *dep. of Kagoshima, prov. of Satsuma.* *Kinrandé* (a kind of Satsouma *faïence*); flower vases in red and gold Satsouma *faïence* (by K. Taziri); vases; lamp bodies; brush trays; *bonbonnières;* water jugs; perfume boilers and burners; tea sets; coffee cups; sugar bowls; milk jugs, etc.

KANZAN (D.), *Kioto.* Porcelain tea and coffee services; flower vases and pots.

KATÔ (G.), *dep. of Gihu, prov. of Mino.* Porcelain flower vases; coffee cups; ash trays.

KATÔ (H.), *dep. of Aichi, prov. of Owari.* Porcelain; pictures; flower vases.

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PLATE II.

JAPAN.
(Grafito tile by Solon.)

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PLATE 11.

JAPAN.
(Grafito tile by Solon.)

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KATÔ (K.-A.), *dep. of Aichi, prov. of Owari.* Porcelain with designs in blue colors; flower vases; panel plaques for doors.

KATÔ (K.-I.), KATÔ (N.), KATÔ (S.-S.), *dep. of Aichi, prov. of Owari. Faïence;* tea-pots; seats; filters.

KATÔ (M.), *dep. of Aichi, prov. of Owari.* Porcelain; flower pots; tea-pots; table services.

KATÔ (M.), *dep. of Aichi, prov. of Owari.* Porcelain; flower pots; small boxes.

KATÔ (S.-H.), *dep. of Aichi, prov. of Owari.* Porcelain cups.

KAWAMOTO (H.), *dep. of Aichi, prov. of Owari.* Vase with feet, with porcelain cover.

KAWAMOTO (M.), *dep. of Aichi, prov. of Owari.* Porcelain; flower vases; basins.

KAWAMOTO (R.), *dep. of Aichi, prov. of Owari.* Porcelain; tea services; coffee cups; small flower vases.

KIN-KÔ-ZÂN (S.), *Kioto. Faïence;* flower vases; pots; perfume-burners; flower pots.

KIRIU-KÔ-SHÔ-KUAÏSHA (Société Industrielle et Commerciale), *Tokio.* Ancient porcelain; pots; flower vases; perfume boxes, burners, and boilers; furniture; tea cups; plates and dishes; bottles; cups; small tea-pots; trays for flower pots, etc.; ancient *faïence;* vases; ash trays; tables; wine jars; bottles; stew-pans.

KOBAYASHI (M.), *dep. of Miye, prov. of Ise.* Boilers in *faïence.*

KORAN-SHA, *dep. of Nagasaki, prov. of Hizén.* Porcelain; pots; jars; flower vases; gourds; covered bowls; perfume boxes and burners; furniture; lamp bodies; coffee cups; tea services; cup; plates; dishes; statuettes; toilet articles.

MAROUNAKA (M.), *dep. of Ishikawa, prov. of Kaga.* Porcelain; flower vases; perfume-burners; pots; cigar-holders; coffee and tea-services; dishes; plates; cups; *bonbonnières;* covered bowls; pictures.

MATSOUMOTO (Y.), *Tokio.* Flower vases and porcelain pictures.

MINODA-CHIOJIRO, *Tokio.* Ancient *faïence;* perfume-boilers; furniture; tea-pots and tea-cups; flower pots; bowls; covered bowls; water jugs; plates; dishes; trays; coffee services; perfume-burners; tobacco jars; bottles; *bonbonnières;* spice boxes; *faïence.*

MIOURA (G.), *Tokio.* Porcelain lamp bodies.

MIYAGAWA (K.), *dep. of Kanagawa, prov. of Musashi.* Porcelain; flower vases; perfume-burners; tea-pots; *faïence;* pictures; flower pots and vases in *faïence* by Mokouzou and Onissi.

MIYAÏ (S.), *dep. of Wakayama, prov of Kii.* Porcelain flower vases.

MORI (S.), *dep. of Miye, prov. of Ise. Faïence* tea-pots.

MORI (Y.), *dep. of Miye, prov. of Ise. Faïence* flowe vases.

MOURAYAMA (K.), *dep. of Miye, prov. of Ise. Faïence bonbonnières.*

NAGASAKI (Department of), *prov. of Hizén.* Porcelain; plates; tea cups; beer jugs; cups.

NAGAYA (Y.), *dep. of Hiogo, prov. of Setzu.* Porcelain; milk jugs; flower vases; insulators.

NAKAYAMA (M.), *dep. of Miye, prov. of Ise. Faïence;* flower vases; coffee services.

OUN-RÏN-ÏN (B.), *Kioto. Faïence;* perfume-burners; flower vases.

OUTSIMOTO (K.), *Kioto. Faïence* flower vases.

SAKATA (K.), *Kioto. Faïence bonbonnières.*

SAÇADA (K.), *dep. of Ishikawa, prov. of Kaga.* Porcelain flower vases.

SATÔ (K.), *dep. of Miye, prov. of Ise. Faïence* flower vases.

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JAPAN.

List of exhibitors, Class 20: Ceramics.

SEIHOU (Y.), *Kioto.* Porcelain flower pots and water pitchers; *faïence* flower pots.

SIGUÉTOMI (H.), *dep. of Miye, prov. of Ise.* *Faïence* perfume-burners.

SIMIZOU (H.), *Kioto.* Porcelain flower and water pots.

SIMIZOU (R.), *Kioto.* Porcelain and *faïence* flower pots and covered bowls.

SHIPPO-KUAÏSHA, *dep. of Aichi, prov. of Owari.* Porcelain; pictures; chimneys; round plaques and door swings; tables; *faïence;* round and square tiles; porcelain with *cloisonné* enamel; sugar bowls; tea-pots coffee cups; covered vases; flower vases and pots; plates and dishes in lacquered porcelain.

SITOMI (S.), *dep. of Miye, prov. of Ise.* *Faïence; bonbonnières;* flower vases; perfume-burners.

TAKAGUI (K.), *dep. of Miye, prov. of Ise.* Boilers in *faïence.*

TAKAHASHI (D.), *Kioto.* Flower vases in porcelain.

TAKAOKA (G.), *dep. of Hiogo, prov. of Setsu.* *Faïence;* fan-holders; ink-stands; furniture; tables; tea-pots.

TAKASSOU (K.), *dep. of Aichi, prov. of Owari.* Porcelain; water and milk jugs: flower vases; table services; coffee cups; cigar-holders.

TANI (S.), *dep. of Miye, prov. of Ise.* *Faïence* tea-pots.

TANZAN (S.), *Kioto.* *Faïence;* trays; perfume boxes; flower vases.

TSOUKADA (K.), *dep. of Miye, prov. of Ise.* *Faïence* tea-pots.

YAMADA (M.), *dep. of Aichi, prov. of Owari.* Pictures; porcelain (*Kinrandé*) tea-pots and covered bowls, made by Kawamoto; porcelain plaques (*Kinrandé*, by Katô); pictures in *Kinrandé* porcelain (Katô).

YAMAMOTO (K.), *dep. of Miye, prov. of Ise.* *Faïence;* tea services; jars.

YAMANAKA (T.), *dep. of Miye, prov. of Ise.* *Faïence;* bowls; tea-pots; flower vases.

YEÏCINSHA, *dep. of Aichi, prov. of Owari.* Porcelain; covered bowls; screens; furniture; flower vases; pictures; jars; water pots; water and tea pots; tea cups, etc.

YEIRAKOU (K.), *Kioto.* Flower vases; covered bowls; vases in *Ninseigaki* ware; plates and dishes in *Kôtsiyaki* ware (by Nissiyama); *bonbonnières* in *faïence*, by Imai.

YEIRAKOU (K.), *dep. of Aichi, prov. of Owari.* Porcelain; flower vases; pictures.

YOKOÏ (S.), *dep. of Aichi, prov. of Owari.* Porcelain flower vases.

YOTA (M.), *dep. of Hiogo, prov. of Setsu.* Porcelain; flower vases; wine jugs; hand-warmers.

WAKÉ, (K.), *Kioto.* Porcelain; flower vases; coffee services; perfume-burners.

UNITED STATES.

UNITED STATES.

The ceramic industry of the United States was represented by three exhibitors only:

List of exhibitors, Class 20: Ceramics.

CARR, JAMES, *New York City.* Pottery and parian ware. Silver medal

OTT & BREWER, *Trenton, N. J.* White and colored vases, busts, etc., in true porcelain. Bronze medal.

MCLAUGHLIN, LOUISE, *Cincinnati, Ohio.* Painted porcelain and pottery. Honorable mention.

Comparison with exhibit at Philadelphia.

Evidently this exhibit was wholly disproportioned to the extent of the pottery interests of the country. At Philadelphia, in 1876, there were over 60 exhibitors, and at the

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recent exhibition by the American Institute in New York there were many exhibits, any one of which was more extensive than our whole ceramic display at Paris.

Poverty of display.

But our pottery interests are not declining—far from it; they are, on the contrary, expanding with great rapidity and strength. Fostered and encouraged by the duties laid upon the importation of foreign ware, they have been protected in their infancy; capital has been encouraged to lend its aid, and as a result we now have well-established potteries, producing, at the present time, enough to supply about two-thirds of the demand. The quality also has been improved until our stone china ware is fully equal to, if not superior to, any of the same grades made in England. The price has also been reduced so that all classes of pottery made in the United States are supplied to the consumer at lower prices than when we were dependent upon foreign manufacturers, and when the duty was only 25 per cent.

Increase of our pottery interests.

Fostered by protection.

Improved quality.

Reduced price.

The pottery industry of the United States is one of the best examples of the beneficent workings of a protective tariff in a new and undeveloped country. Blessed as we were with an abundance of the best materials for pottery lying at our very doors, with transportation by water and rail for the breadth of a State, alongside of inexhaustible beds of the finest clays, with fuel, either coal or wood, abundant and cheap, and men seeking employment, we were importing nearly all of our domestic ware from the ancient potteries of Staffordshire and France. Capital found no encouragement to open our clay beds or to erect a kiln, and the prejudice of the people was strong in favor of imported ware and against any made at home. Nothing short of a protective duty could have brought our potteries into successful existence. In 1860, according to the census returns, there were 557 establishments, with an aggregate capital of $1,341,774, employing 908 hands, and paying $934,918 a year in wages, and annually turning out $2,463,681 in value of products. There are now in the country some 800 potteries, with a capital of $6,500,000, employing 7,000 hands, and paying annually $2,500,000 in wages, and producing $7,000,000 worth of wares annually.

Workings of the protective policy.

Our abundance of materials.

Prejudice in favor of foreign wares.

Statistics of our production.

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UNITED STATES.

Our imports have been largely from Great Britain, as the following tabular statement, for eight years, will show:

Imports of ceramic products, 1870–1878.

Import entries into United States of china, porcelain, earthen, and stone ware from all countries, and portion from Great Britain alone.

Years ending June 30—	From all countries.	Portion from Great Britain.	Percentage from Great Britain.
1870	$4,388,771	$3,571,859	81.386
1871	4,681,376	3,889,397	83.082
1872	5,270,785	4,151,150	78.758
1873	6,015,925	4,646,688	77.240
1874	4,882,355	3,820,030	78.242
1875	4,265,210	3,276,872	76.828
1876	4,304,808	3,001,641	69.728
1877	3,709,542	2,796,380	75.383
1878	4,051,786	3,082,355	76.074
Totals	41,570,558	32,236,372	77.546

Imports for 1879.

The imports from all countries for 1879 were $4,044,876 in value, which is about 8.18 cents per capita. While our percentage of imports from Great Britain is about 75 per cent. of our total imports, over one-third, or 34 per cent., of the British exports of pottery are to the United States, as shown by the following figures compiled from the British Trade Returns:

Exports from Great Britain, 1870–1879.

Exports from Great Britain and Ireland of earthen and china ware, parian, and porcelain, except red pottery and brown stone ware.

Years ending June 30—	To all countries.	Portion to United States.	Percentage to United States.
1870	£1,707,645	£710,735	41.621
1871	1,617,493	713,218	44.094
1872	1,847,501	750,283	40.611
1873	2,120,210	794,432	37.469
1874	1,842,011	584,406	31.727
1875	1,731,240	595,200	34.380
1876	1,743,700	584,581	33.525
1877	1,666,723	548,677	32.920
878	1,750,877	603,789	34.485
879	1,714,700	588,423	34.315
Totals	17,742,166	6,473,750	36.488

Increasing production of French and German potteries.

The increasing production of the French and German potteries, and the marked improvements in the quality of the ware, and its cheapness, have no doubt also affected the trade of Great Britain with other countries in the products of the Staffordshire potteries. Already French ornamental tiles compete with the British in the New York market. In regard to the trade in Staffordshire in the Exhibition year, 1878, I append a note published in England reviewing the trade for that period.*

Trade of the Staffordshire potteries.

*"THE TRADE OF THE STAFFORDSHIRE POTTERIES.—The trade year in the potteries which has just closed has been more unsatisfactory than

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Our receipts of British pottery for the year 1879 are shown in detail by the following tables compiled by Mr. David Inglis, 6 New Hall, Liverpool, and published in the London "Pottery Gazette," February 1, 1880: UNITED STATES.

EXPORTS TO AMERICA.

[Compiled by Mr. David Inglis, 6 New Hall, Liverpool.]

British pottery exports to the United States.

The total exports for the year 1879 amounted to 75,701 packages, an increase over 1878 of 11,240 packages.

	Shipments for weeks ending Dec. 31, Jan. 6, 13, 20, 1880.	Corresponding weeks, 1879.	Exports, Jan. 1 to Jan. 20, 1880.	Corresponding period, 1879.
To Boston	1,507	736	1,244	1,061
New York	2,400	1,027	2,280	825
Philadelphia	1,242	275	1,574	489
Baltimore	257	130	396	94
San Francisco	135	234	119	314
Mobile, Charleston, New Orleans, Portland, Galveston, and Savannah	328	399	479	526
Total packages	5,869	2,801	6,092	3,309

Trade of the Staffordshire potteries.

any year since the Crimean war, and at the present time, though in special branches of the trade men are working nearly full time, not more than half the producing power of the district is in operation. The declared value of the goods exported in the first nine months of 1878 was £1,260,590, against £1,288,777 in 1877, and £1,270,606 in 1876. The value of the goods shipped for the United States in the same period was only £414,404, against £454,353 in 1877, and £425,806 in 1876. The orders received from America have fluctuated month by month, and the value of the goods shipped in September dropped down to £36,000, which was little more than half the value of the business done in some of the other months. There has been an increase of business with British North America, while the orders from Brazil and all the other parts of South America have been scarce throughout the year. The goods made for the French market show a considerable improvement in value to those of previous years, but this is in no degree attributable to the Exhibition, which has been productive of very few orders for this district up to the present time. Germany has purchased less British pottery this year than usual, and we are assured that the German potters are greatly increasing their production of light, hollow wares and are driving English goods out of some markets, particularly in the Mediterranean ports. In Italy, Holland, and Spain there has been an improved demand, which in some measure compensates for the falling off in Germany and America, but from India and Australia fewer orders have been received. There is a prospect of an increasing business being done with the Cape Colony. Neither Turkey nor Russia has yet recovered from the effects of the war, and while business with the former continues entirely suspended, not a tithe of the ordinary business with Russia has been done during the past year. The home trade is extremely unsatisfactory, and travelers report an increasing difficulty in obtaining orders or the settlement of accounts.

Exports to United States;

To France;

To Germany;

To Italy, Holland, Spain, etc.

Home trade.

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UNITED STATES.

British pottery exports. 1869–1879.

Exports for—	Packages.	Exports for—	Packages.	Exports for—	Packages.
1869	104, 934	1873	77, 528	1877	69, 951
1870	97, 220	1874	65, 164	1878	64, 461
1871	103, 669	1875	66, 209	1879	75, 701
1872	104, 185	1876	60, 193		

Earthenware exports.

British exports of earthen and china ware, parian, and porcelain. 1877–1879.

Our exports of earthen and china ware, parian, and porcelain (except red pottery and brown stone ware) for the periods mentioned have been as follows:

	Month ended December 31—			Twelve months ended December 31—		
	1877.	1878.	1879.	1877.	1878.	1879.
To Germany	£4, 851	£6, 481	£3, 812	£60, 434	£48, 617	£40, 365
France	6, 558	5, 664	7, 260	74, 309	91, 686	83, 933
United States	42, 456	35, 034	49, 828	619, 050	582, 018	681, 935
Brazil	11, 682	7, 264	8, 069	133, 636	111, 000	108, 679
British North America	3, 554	4, 062	4, 055	95, 488	92, 584	65, 821
British India	11, 144	9, 543	5, 561	127, 873	105, 708	87, 966
Australia	17, 555	10, 829	9, 443	203, 546	189, 918	217, 882
Other countries	39, 804	36, 708	31, 625	446, 354	501, 233	455, 047
Totals	137, 604	115, 585	119, 653	1, 766, 690	1, 722, 794	1, 741, 628

British glass exports. 1877–1879.

Glass exports.

	Month ended December 31—			Twelve months ended December 31—		
	1877.	1878.	1879.	1877.	1878.	1879.
Plate, rough or silvered, including looking-glasses or mirrors, framed or not	£7, 164	£11, 973	£12, 243	£128, 663	£106, 762	£133, 698
Flint, of all kinds	18, 187	16, 875	16, 702	268, 229	239, 747	231, 042
Bottles and manufactures of green or common glass	28, 782	23, 525	27, 174	336, 754	310, 307	305, 741
Other manufactures, unenumerated	8, 649	5, 468	10, 813	120, 823	99, 068	113, 393

United States Potters' Association.

The American potters, by associating themselves and working as a unit, have accomplished much for the advancement of their industry. They have annual meetings for the interchange of information and for discussing the interests of the trade. Fifty-five or more well-known pottery firms are enrolled as members of this United States Potters' Association. It appears by a report of one of their recent meetings at Trenton that the value of the annual production of white granite ware, C. C. ware, and china ware is now about $4,000,000, a few thousands of dollars less than the aggregate value of the importations of crockery and china. Over 30 new kilns were built in the country in the

Annual value of white granite ware.

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year 1879, and additions have been made to almost every pottery. At some of the potteries schools of design have been established for the workmen by the proprietors. Efforts are making to produce ware in more artistic forms and colors. Up to the close of the centennial year, 1876, the attention of our potters was given almost exclusively to the manufacture of plain white granite ware, which has been carried to great perfection, rivaling in compactness of body and hardness of glaze the best granite ware of Staffordshire. From the report of Messrs. Carr, Martin, and Morley, a committee of the association upon statistics, it appears that 28 years ago there was one pottery in the country, making about 60 glost kilns per annum, 30 of which were white and 30 yellow and Rockingham ware. That was all the white ware made in the United States at that time except some porcelain door-knobs made by Charles Castlyn, of Greenpoint. The materials were all or nearly all imported from abroad.

UNITED STATES.

Schools of design.

Increase of potteries.

In respect of materials, the chairman of the committee on raw materials, Mr. Thomas C. Smith, of Greenpoint, says:

Materials.

"There is, beyond any doubt, more material and as good material in this country as in any country on the globe. But so far as our present knowledge extends nature has not compounded it and deposited it within a small area almost ready for use as has been done in some sections of other countries, notably in France, at St. Yrieix. With us our material must be gathered from many different States of the Union. Pennsylvania, Delaware, Missouri, and Illinois are known to have large deposits of fine porcelain clay. New York, Connecticut, Massachusetts, Virginia, Ohio, and some other States have sent samples that show great promise. But our methods of testing and using clays are crude and empirical to the last degree."

Not compounded and deposited as at St. Yrieix.

Gathered from various States of the Union.

It is true, perhaps, that our methods of testing are crude, but in the nature of the case the testing and compounding of clays and other ingredients must be empirical, though much aid may be had from the chemist, and especially from a knowledge of the properties of the substances used. Chemists can indicate the composition of materials and guide the compounder of pastes, but there may be mechanical differences of fineness and texture which will affect the product more than the presence or absence of small quantities of impurities. But systematized empirical trials would accomplish much for our potters. They do not enjoy the patronage of the state. No imperial or republican national establishment tries the clays and spars of the whole country for them, as is now done abroad, and has been for generations, at Berlin, Meissen, and at Sèvres.

Tests principally empirical.

Chemical and mechanical differences.

No national establishment for testing material as at Berlin, Sevres, etc.

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UNITED STATES.

California pegmatite and kaolin.

We have vast hidden resources of porcelain earths from one side of the continent to the other. In California there is a whole mountain range of pegmatite of snowy whiteness, and no doubt along its flanks great beds of kaolin, all resting undisturbed, lie inviting enterprise and capital.

The manufacture of porcelain in the United States is no novelty. It was commenced early in the present century near Philadelphia. It is now made in large quantites at Greenpoint, Long Island.

Thomas C. Smith's Greenpoint porcelain.

The Greenpoint porcelain of Mr. Thomas C. Smith has had gratifying success. The products of his kilns are used all over the country, chiefly perhaps by hotels and public houses. The quality is being constantly improved, and a lighter, thinner ware is now made for domestic use.

Laughlin's china works.

China works at Philadelphia are projected by Mr. Laughlin, in which it is proposed to make a superior quality of hard porcelain for domestic use.

American encaustic tiles.—Within a few years the manufacture of encaustic and enameled floor and wall tiles has been commenced in the United States, and bids fair to become a very important industry. Already the American Encaustic Tiling Company, of New York, has executed some important orders, and is prepared to furnish tile paving of excellent quality at a moderate price. Their tiles are made from the clays of Ohio.

American Encaustic Tiling Company.

Enamels.

Enamels.

It was very interesting to observe the increasing extent of the use of enamels in interior decorations abroad and the rapid development of the industry, particularly in the production of the style of enamels generally known as Limoges enamel, of which so many choice examples are found in the museums of Europe, while they are, to the mass of the people at least, comparatively unknown in the United States.

This division of the report may include, however, all the forms of the enameler's art, on a ceramic or metallic base, whether for purely decorative purposes or for objects of daily use.

Limoges enamels.

Limoges enamels.

Paul Soyez.

Paul Soyez, of Paris, was one of the chief exhibitors, and received a gold medal. His enamels are upon copper, chiefly in the old Limoges style, and include, besides original pieces, many copies of the most celebrated works of the old Limoges enamelers. Among the more important objects shown

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were a mirror frame in the style of Francis II, with enameled plates or panels, each about 8 inches wide, the mirror frame being 2 meters by 1 meter, and valued at 4,500 francs; a clock with ebony case inlaid with enameled plates, together with two enameled candlesticks, in the style of Henri II, for 6,000 francs; two vases, "Peace and War," 20 inches high; also a magnificent ewer and a small tazza, 4 inches broad and 4 inches high, "Venus at her toilet," surrounded by a border of exquisite work—value 3,000 francs. *Enamels.* Limoges enamels. Plates, panels, vases, and tazza.

He also manufactures exquisite clock dials and small panels for insertion in clock cases, and in furniture, cabinets, etc.

CHARLOT FILS. Charlot *fils.*

Most of the objects shown by this exhibitor are small, and are designed chiefly for jewelry, such as flowers, leaves, butterflies, shells with pearls, and leaves with dew-drops, beetles, and small medallions for jewelry. He exhibited also a clock face of silver, enameled and decorated with figures, and small panels for the sides of the clock. The paintings are extremely fine and excellent in color and finish. Price of the set 6,000 francs. Jewelry, enamels, and medallions.

ROBILLARD FILS. Robillard *fils.*

Exhibition of enamels in Limoges style; imitations and restorations. They make large and small pieces, such as plaques for insertion, boxes, salts, candlesticks, *beaubeches*, bottles, and mountings for choice glass tankards, bowls, and trays. This establishment has been producing for thirty years, and exports largely to England, Austria, and the United States. Imitations and reproductions.

DALPAYRAT & LOT. Dalpayrat & Lot.

This firm of enamelers is established at Limoges. M. Dalpayrat is himself an artist painter on enamels and ceramic vases and a professor at the Limoges Municipal School of Design. Although engaged for the last thirty years in painting upon porcelain and *faïence*, he is now devoting his attention chiefly to painting or enameling upon copper, producing large pieces for decorative purposes, and exact reproductions of the ancient enamels of Limoges, and by the same processes. They have introduced some new colors and some new methods, which give beautiful results. Limoges Municipal School of Design.

Their exhibit showed great command of the enamels. There are numerous large panels and many vases and objects spun upon copper, such as columns, lamp stands, and candlesticks. Productions.

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Enamels. Dalpayrat & Lot.

This hollow work, covered with an *aventurine* or gold enamel, is one of their specialties.

Some of their enamels are enriched with plates of burnished silver and of gold, such as leaves, branches, the moon or the sun, birds, etc. When these are covered with enamels of the proper tint and transparency, as, for example, blue or green, the silver shows through, giving a beautiful effect.

Duron.

DURON.

One of the most beautiful and costly objects in enamel is executed by the jeweler Duron (the enameling, however, by Soyer). It is a group of naiads rising from the sea and supporting a shell; in this case a shell made of onyx, about 6 inches long. The bodies of the naiads are of fine gold, carefully wrought and molded, but every part except the hair is covered with an exquisite flesh-colored enamel.

Cloisonné.

Cloisonné enamels.

The shops of China and Japan have been wonderfully prolific of *cloisonné* enamels in the last decade.

There is nothing new or remarkable to chronicle concerning the exhibit at Paris in 1878, except perhaps the unusual size of the pieces shown in the Chinese section. For example, there were braziers standing 3 feet high and a pair of Pekin *cloisonné* vases with a red ground and fret pattern, and large flowers, peonies, and branches of full size. These stood 6½ feet high, and were exhibited by Té-Tschen.

Chinese braziers and vases.

Japanese.

In the Japanese section there were some jet-black enamels with a very high polish, and some blue and yellow enamels of unusually bright color. In some of the enamels the vases were enriched by the attachment of highly-wrought metallic medallions or panels on the sides.

Cloisonné on porcelain.

Specimens of *cloisonné* on porcelain were numerous.

Enameling on iron.

Enameling on iron.

A very considerable manufacture is now established in Paris of enameled cast and sheet iron for out-door furniture, garden seats, flower boxes, vases, and fountains. The colors are chiefly white and blue, and are burned on at a high temperature. There were numerous specimens throughout the grounds and gardens of the Champ de Mars.

Out-door objects, flower boxes, seats, etc.

The most important of these objects were the very large flower vases, or tubs, which held the palms upon the pediments of the entrance steps. These vases, of circular form, flaring towards the top, and standing from 3 to 4 feet high,

Flower vases.

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appeared to be in one piece, but were, in reality, made up of segment plates bolted together on the inside. Each vase was formed of six segments, cast with projecting ears inside, by which they were connected together by means of stove bolts. One pattern for one segment sufficed for all. It forms a simple casting, the pattern is easily made, and it would seem that in this manufacture there would be considerable profit in the United States, especially in supplying our parks and public conservatories with large vases for flowering or decorative plants. The enamels described are made by E. Paris & Co., and are patented in several countries. They also make numbers and name-plates for streets of cities.

Enamels.

Enameling on iron.

E. Paris & Co.

"Granite" enamel on sheet iron.—Saint Louis Stamping Company.

Saint Louis Stamping Company.

One of the greatest novelties at the Exhibition was found in the remarkably strong and enduring enamel which has of late been invented and brought to perfection in the United States by the Saint Louis Stamping Company, F. G. Neidringhaus president. It is known as the "granite iron ware," and is especially adapted to all hollow ware of sheet-iron, such as cooking utensils, coffee and tea pots, cups, basins, pans, etc. Its gray mottled color is familiar to our housewives, and it is becoming better known and more popular every year. This enamel consists of an insoluble, tough glaze, partaking of the qualities of porcelain and of glass. It is not poisonous. It adheres closely to the iron, and is not easily broken or flaked off. It withstands the action of acids, and resists fire extremely well. It is easy to clean. It does not discolor the viands cooked in it, and is, in every respect, preferable to tin-lined or other metallic vessels.

F. G. Neidringhaus.

Granite iron ware.

Character of the enamel, and of the ware.

With these qualities, and having at the Exhibition a variety of the most tasteful forms of coffee and tea sets, beautifully mounted in nickel silver or nickel plate, it is not surprising that the jury were unanimous in awarding the gold medal and in recognizing in this enamel a most important advance in the manufacture of domestic utensils.

Exhibit.

The works occupy nearly two blocks of buildings in Saint Louis. In 1878 from 400 to 500 men were employed, and the value of the production had then, three years after the introduction of the enamel, reached $750,000.

Works.

Enameled signs.

Enameled signs.

Travelers by the underground railway in London must have observed the neatly executed names of stations in white on a blue background. These are, for the most part, enam-

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Enamels. eled on sheet-iron plates, and are made by Willing & Co., of St. Martin's Lane, London. The name-plates of the streets in London are, to a great extent, supplied by the same firm.

Enameled signs. These enamels are remarkable for their size and legibility, and for their strength and cleanliness. They are vastly preferable, especially in a smoky atmosphere, to any other known form of sign or guide-plate.

For signs—such, for example, as Regent street—on plates 7 inches wide and type or letters 3¼ inches high, in white on Price. a blue ground, with border line, the price is nine pence per letter. For blue on white, 6-inch plate and 4-inch letters, the price is nine and a half pence per letter. Many of these enameled signs for railway stations are several feet in length, with a continuous, unbroken surface of dense, smooth enamel.

Tiles. *Floor, wall, and ornamental tiles.*

The display of tiles, particularly from Great Britain, was Advance in British manufactures. very large, and in many respects showed an advance in the manufacture since the Exhibitions of 1876 at Philadelphia and of 1873 at Vienna. The manufacture of all varieties of encaustic and of enameled or glazed wall tile has nowhere been carried to greater perfection than in England. The Mechanical and artistic skill. highest skill of the compounder of clays and the best efforts of decorative artists are called into requisition in this industry, and the resources of the chemist's art applied to glazes and enamels are taxed to their utmost in the production of the most brilliant colors. Graphic and chromatic Graphic and chromatic decorations. decorations in ceramics find in this field their legitimate basis of application and their greatest possible expansion in the future. The great object of the tile is decoration; and the flat surface in the wall or on the floor is more appropriately the basis of ornament than a plate or dish on which, when in use, the decoration is obscured. The antiquity of the art. tiquity of the art of decorating with tiles is well known, and the perfection which it attained in several countries is shown by the specimens which have been handed down to us unchanged—not even dimmed by age. The tiles of India, India, Persia, Arabia, Spain. Persia, Arabia, and Spain, the mosaics of the Romans, and Roman mosaics. the walls of the Alhambra, are familiar examples. Glazed Egypt, Assyria. decorated tiles were used in Egypt, and among the Assyrians and Babylonians. They were introduced in Spain by China. the Saracens and Moors. In China they were employed in remote periods for both exterior and interior decoration. The Exposition contained specimens of antique tiles from India and other countries.

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Manufacture of tiles in Great Britain. *Tiles.*

The manufacture in Great Britain dates from mediæval times, and is supposed to have originated in the Roman mosaics—the transition from *tesseræ* to the tiles, with impressed designs, being gradual, the difference in the first place being in the size of the pieces only. Evidences of the gradual modification of the size have been found, and in Spain small tiles, intermediate between British tiles and *tesseræ*, are now in use. Excavations at Chichester have brought to light mosaic pavements and Roman tiles.

Manufacture in Great Britain.

Roman *tesseræ*.

Roman pavements and tiles at Chichester.

It is highly probable that the convenience and greater rapidity of laying larger tiles led to their adoption, and the requirements of the details of design led to the quicker and cheaper method of stamping the figures upon the clay. For a long period after the use of the red or Samian ware introduced by the Romans ceased, tiles appear to have been the only branch of the decorative fictile art in Britain. They were applied chiefly in ecclesiastical decoration, about the altars and choirs, and for memorial purposes. The excellence of this mediæval tile work is regarded as having stimulated and led the way to improvement in decoration of household pottery. Some of the earliest specimens of the art preserved in the British Museum are from ruined churches in Norfolk. The neighborhood of Great Malvern appears to have been one of the chief centers of production in the thirteenth and fourteenth centuries, and few churches in Great Britain can show a greater variety of ancient tiling than the Priory Church of Great Malvern, the interior of which abounded with encaustic tiles in the floors and forming panels in the walls.

Red ware introduced by the Romans.

Mediæval tile work.

Works at Great Malvern.

The manufacture in Britain has been assigned to two periods. The most ancient tiles are believed to have been fabricated between the years 1290 and 1380, and those of the second period during the prevalence of the perpendicular style in building. Numerous kilns have been unearthed at Malvern Hills, and it is believed that Tewkesbury Abbey and Worcester and Gloucester Cathedrals were supplied with tiles from these kilns. The manufacture is supposed to have been continued in Worcestershire down to about the year 1640, and to have been repressed, if not stopped, at that time through the influence of Puritanism. In that year visitors were appointed to visit the ecclesiastical structures of the kingdom and destroy all ornaments of a "superstitious nature."* The designs upon the tiles at that time

Two British tile periods.

English cathedrals.

Iconoclasm.

* "Antiquarian and Architectural Year Book," 1844, p. 128.

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Tiles.

were largely formed of sacred symbols and inscriptions, of memorial letters and monograms, and of heraldic devices, chiefly in connection with tombs. These mediæval tiles have been classed, according to their decorations, as follows:

Mediæval tiles of English cathedrals.

Character of the decorations.

1. "Sacred symbols; inscriptions, consisting either of verses of the Scripture or pious phrases."

2. "Armorial bearings of the sovereign or individuals connected with the monastery by benefactions or otherwise; personal devices or mottoes."

3. "Ornaments conformable to the style of architecture or character of decoration prevalent at the period, but devoid of any special import."

Some of the emblematic figures consist of lions, dragons, and adders, and have been supposed to have reference to the text, "Thou shalt go upon the lion and the adder: the young lion and the dragon shalt thou tread under thy feet."

Sizes.

The tiles of the earlier manufacture generally measure 5″ square, and those of the latter period 6″. Some have been found 9″ square and 2¼″ thick.

Material.

The material is ordinary coarse red clay, such as is used for making brick, and the design appears to be formed by a lighter colored clay filling incisions or impressions in the surface, and subsequently glazed. The design is supposed to have been impressed by a stamp while the clay was still moist, and the depression so formed was filled by the lighter clay in the condition of thin paste, for the cavities are frequently seen to be but partially filled.

Mode of making.

Prosser's method.

Prosser's method.

Tiles are no longer made in Great Britain in this manner. Prosser's method, patented some thirty or forty years ago, and perfected by Mr. Minton, marks a new era in tile manufacture, and has contributed greatly to the advance of this branch of artistic decoration. It consists chiefly in the use of powdered clay, instead of the wet, plastic mass. The paste being duly compounded of the proper clays and silex, and strained through cloth, is dried and then ground to powder. This powder, when slightly damp, is pressed in steel molds by a powerful screw. The size and form of the molds determine the size and shape of the tile. Tiles so formed are more perfect in shape, are denser, stronger, and more uniform in wear, than those made from clay in its plastic state. There is less shrinkage in firing, and little or no distortion. Most of the cheap tiles upon the Continent are made by the old methods, and are by no means so exact in their forms and sharp in their edges and

Minton.

Pressed tiles.

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angles as those made from the damp powder under pressure, in accurately formed molds. *Tiles.*

The exactness and uniformity of size obtained by the new method greatly stimulated the industry, and it has been steadily increasing in importance to the present time. Many firms are now engaged in the manufacture in Great Britain, particularly at Stoke-upon-Trent, and Burslem in Staffordshire. The establishment of Messrs. Minton, Hollins, & Co., now carried on by Mr. Hollins, is one of the oldest, and is occupied exclusively in the production of all varieties of tiles. The Prosser-Minton method. Minton, Hollins, & Co.

The rapidly increasing demand for tiles of all descriptions of late years is remarkable, not only in England but throughout Europe. They are used in almost all modern buildings of any pretension. They make the most serviceable and ornamental floors for public buildings. In the South Kensington Museum alone there are some 40,000 square feet of pavement laid. They are used in railway stations, on shipboard, and for decorating walls and pavements of churches. For this latter purpose great numbers are required in the work of restoration of old cathedrals. At Worcester, the cathedral which has lately been restored, chiefly through the munificence of Earl Dudley, who gave $350,000 for the purpose, has a tiled chancel of most elaborate design, a part of which is over four hundred years old. The dilapidated portions have been renewed with tiles made in exact imitation of the ancient tiles, and at a cost of not less than $10,000, under the direction of Sir Gilbert Scott, the architect. Modern uses of tiles. South Kensington Museum. Worcester Cathedral. Sir Gilbert Scott.

Varieties of tiles. Varieties of tiles.

The varieties of tiles as now made may be classed, according to their manufacture, irrespective of form or use, as follows:

1. Plain tiles, unglazed, glazed, or enameled in colors.
2. Encaustic tiles, unglazed or glazed.
3. Majolica tiles.
4. Enameled, decorated, or painted tiles.

The plain tiles are usually made from natural clay mixtures, selected with reference to their colors when burned; or coloring substances may be added. The color pervades the whole tile like a brick, not being, as in the case of an enamel, merely superficial. The addition of a transparent glaze makes the color more brilliant, and gives a smoother surface. The general colors of both the plain tiles are black and white, red, chocolate, salmon, drab, and buff. But almost any desired color can be given to plain tiles by Plain tiles. Character. Colors.

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Tiles.

enameling them upon the surface with opaque enamels. For this process the plain white, buff, or red tiles are taken. Bright reds, crimson, purples, blues, greens, and browns

Enameled tiles.

may thus be obtained. These enameled tiles, like the glazed, have a smooth glassy surface, and are more appropriately used upon walls than in pavements, where the attrition would soon destroy the gloss of the enamel and produce scratches. The smooth surface is also rather slippery and dangerous to walk upon. For these reasons the plain unglazed tiles are to be preferred for pavements.

Beside the use of the glazed and enameled tiles in mural

Decorative and domestic uses.

decoration for dados, panels, etc., they are especially applicable, and are largely used abroad, for lining the walls of dairies (the dairy farmers finding them superior for cleanli-

Dairies, kitchens, bath-rooms, stables, etc.

ness and keeping the milk pure), for larders, kitchens, around sinks and cooking ranges, in bath-rooms, water-closets, and in stables. For such places the 6-inch plain white glazed tile is in general use. Another very important application of wall tile is in hospitals, for completely lining the walls of wards for fever patients. The new St.

St. Thomas Hospital, London.

Thomas Hospitals (erected in London opposite the Houses of Parliament) have the fever wards lined with 6-inch white glazed tiles, which, it is believed, will prevent the absorption of the germs of disease, which it is well known penetrate porous plaster walls, and are even absorbed by bricks, so that after a time whole wards of hospitals and entire buildings become unfit for occupation. The same is true of rooms in dwellings, hotels, and dormitories in colleges. An impervious tile wall, which can be thoroughly cleaned by

Great sanitary improvement.

wiping with a sponge, is a great sanitary improvement, and deserves the attention of physicians and architects. A thoroughly vitrified body, like porcelain, would be better for the purpose than a porous earthenware base with a glazed surface, though the latter would, no doubt, be far better than even the hardest painted plaster wall.

White glazed tiles as reflectors.

Another important use of the plain white glazed or enameled tiles is as reflectors in lining dark passages, staircases, and entrances, especially in basements, or wherever there is liability to dampness or a smoky atmosphere. They

Stations of the London Underground Railway.

are largely used about the stations of the Underground Railway in London, particularly around the window openings, or wherever light is admitted through thick walls. Most of

Lavatories of European railways.

the lavatories and retiring-rooms of the railway stations in England and on the Continent are lined with white glazed tiles.

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Encaustic tiles may also be either with or without a glaze. In this class the design upon the tile is not merely stamped or painted on the surface, but is impressed to considerable depth. The tiles are *inlaid*. The process in Britain is as old as the mediæval tiles of Malvern, already noted. In the ancient tiles the design was impressed in the moist clay. In the modern it is equally impressed, but at the time of forming the tile out of the dust, leaving a sharply formed design, which is subsequently filled by a powder of another color. The whole being pressed together forms a homogeneous mass. The impressed design is also filled, in some cases, by a liquid slip, as in the ancient tiles, and when dry the excess is scraped off before firing.

Tiles. Encaustic

Ancient and modern methods.

The design being impressed to a depth of one-eighth or one-quarter of an inch, and filled solidly with body of a different color from the groundwork of the tile, is not obliterated by wear until the whole substance of the tile has been cut away to the full depth of the design. The brilliancy of the design and of the colors of the tile may, as with plain tiles, be heightened by a simple glaze; but the surface is made slippery, and is not so well adapted to pavements as the simple unglazed surface. Some of the colored bodies, such as blue, green, and white, are sufficiently vitrified in burning to give a vitreous semi-glazed appearance. But glazed inlaid tiles are suitable for hearths where not exposed to much wear, and are now largely used abroad for this purpose. Their thickness and strength render them secure from breakage.

Unglazed tiles for pavements.

Glazed inlaid tiles for mural decoration.

Encaustic or inlaid tiles are usually one inch thick, twice the thickness required for plain wall tiles. They are especially suitable for pavements in halls, corridors, and vestibules, or wherever they would be exposed to attrition and wear by the fire-irons, etc.

Encaustic and enameled tiles in decoration.

Another important application of the encaustic and also of the enameled tiles is found in decorating the walls of buildings, especially those of brick, either grouped in large panels or set singly about the window-frames and cornices.

Uses in decoration.

The glazed encaustic tiles are generally used in mural decoration and in fire-places, for lining the jambs and back, where movable or basket grates are used. They have the merit not only of beauty, but of cleanliness, as all smoke, soot, or dust can be easily wiped off the glazed faces.

Walls and fireplaces.

Majolica tiles are ornamented with the design in relief, produced generally by the insertion of an open-work metal-

Majolica.

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Tiles.

lic plate when molded, giving them an embossed surface, which is variously colored by enamels, and is highly glazed.

Majolica tiles.

This kind of tile is extremely rich and brilliant in appearance, and is suited to mural decoration, such as the walls and dados of dining and smoking rooms, libraries, offices, stairways, entrance halls, for inlaying cabinet work, and for mantels and fire-places. For this latter purpose there were some fine examples in the exhibition of dog-grates and fire-place fixtures. They are particularly applicable to church-wall decoration, grate cheeks and for flower boxes. So also the enameled ornamental tile may be used for the same purposes, but more especially for the walls of dairies, bathing and retiring rooms, and for baths. The ornamentation is either added by hand or is transferred from lithographic prints, but is all upon the plain surface, not extending into the substance of the tile, as in the encaustic varieties, or raised above the general level, as in the embossed varieties. The elaborately painted tiles and slabs belong to this class, as also those which are enameled in various opaque colored enamels.

Uses in room and fire-place decoration.

Distinctions of—

Majolica,

Encaustic,

Embossed.

The use of tiles for flower-boxes for windows has become general, and has raised a demand for such as are peculiarly adapted to the purpose. They are usually eight inches square, half an inch thick, and are inserted side by side in a simple wooden or zinc frame work, grooved so as to receive and hold the edges of the tiles. The majolica and painted tiles are generally preferred.

Window flower-boxes.

An important application of tiles is for inscriptions of all kinds, street names, signs, numbers, especially where dust accumulates, and frequent brushing or dusting is necessary. They are largely used in the underground railway in London for the names of the stations. Messrs. Minton, Hollins, & Co. manufacture every kind and all sizes of these tiles for forming inscriptions, dates, and texts, and direct attention especially to their letter tiles, manufactured expressly for street names, and assert that such tiles have been fixed in several towns for more than twenty years without being impaired in distinctness. They are affixed either by bedding in Portland cement against the wall, with the edges covered so as to exclude water, or by metal frames secured to the wall by screws, or by cutting out a recess as broad as the tiles and as long as the name requires. The tiles are then secured in this recess by cement, and the joints are pointed.

Name plates and signs.

Modes of attachment.

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Memorial and mortuary tablets. *Tiles.*

For memorial and mortuary purposes encaustic tiles, bearing inscriptions, monograms, or heraldic devices, seem to be peculiarly appropriate. They have the advantage of being comparatively indestructible by the weather, and of holding their colors unchanged by time, so that inscriptions on them remain legible long after those cut in stone have disappeared. The material is far more enduring than porphyry and granite or marble, especially where exposed to the weather; and, even if lost sight of and buried for ages in the earth, tiles, if properly made, will retain their inscriptions in perfection, and may become of great value in antiquarian researches. Being formed in molds, duplicate copies can be made at little increased cost, and they could be freely used, not only in tombstones, but as memorial tablets in the walls of churches. Inscriptions may be made in small but distinct letters, so that a tile of ordinary size may contain all that is usually placed upon a tombstone. The compactness of such inscriptions renders it possible, if desired, to group a number in a small space, and they could be inserted side by side in the walls of vaults, or upon tombstones specially adapted to the purpose.

Memorial tablets. Advantages over marble or stone.

The memorial tablets now made are generally 12″ square, and are designed chiefly for insertion in the walls of churches or chapels. They bear heraldic devices or simple inscriptions, and are variously ornamented and colored.

Early examples of the use of tiles for mortuary purposes are numerous and interesting. Red tiles of this nature, inlaid with black clay, have been found in Devonshire, Somersetshire, and Surrey, England.* It is known that inlaid tiles were used to mark the site of graves in Worcestershire far into the seventeenth century. In Malvern Priory Church, which contains some of the finest examples of heraldic tablets, Richard Corbet, a knight templar, who died in the thirteenth century, has a plain table monument, the sides and ends of which are covered with tiles, 5½″ square and 1½″ thick, decorated with the arms of the Corbet family.†

Early examples of mortuary tablets. Malvern Priory Church. Sir Richard Corbet.

In the same ancient church there were examples of monograms, the letters impressed in the clay and then filled in with white earth, and of pious inscriptions in black-letter in connection with them. Inscriptions formed with small

Monograms.

* "Life of Josiah Wedgwood," Meteyard, i, p. 55.

† "Antiquarian and Architectural Year Book," 1844, p. 147.

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Tiles. tiles, each bearing a separate letter, have been found there, and the grave of Vicar Edmund Rea, 1640, was marked by a border of such tiles, chronicling his death.

Staffordshire mortuary slabs. In the pottery districts of Staffordshire earthenware slabs or gravestones were not uncommon. Several examples, with drawings, of specimens in the Mayer collection are cited in Meteyard's "Life of Wedgwood." One is a tablet 1′ high, 9″ broad, and 2″ thick; another, 2′ 3″ high, 1′ 7″ broad, and three-fourths of an inch thick. One is formed of seggar clay, and the other of dark red clay, and both are inscribed, one with raised white letters, and the other with the letters sunk, and covered with a glaze. All of the inscriptions are remarkably clear.

Building tablets.

Building tablets.

Another example of the use of tiles is found in the building tablets set into the front walls of houses to show the date of construction and the name of the builder or owner. The custom was an old one, and was very generally followed in the pottery region. Some of these were made of light brown clay, with the ornaments in relief in yellow clay. Others are glazed white, with the date and armorial bearings painted in blue.

Mural tile decoration at the Exposition. The Exposition abounded, more than any of the preceding, in examples of the use of tiles for mural decoration. In the French section broad surfaces of walls were covered with

Paris municipal building. painted tiles. The grand entrance to the building, erected by the city of Paris, was adorned by huge enameled tiles and panels of terra cotta. Visitors to the Centennial Exhibition

Haviland *faïence* panel at Washington. in 1876 will remember the large panel exhibited by the Havilands, executed in tiles of the Limoges *faïence*, emblematic of the control of the elements by man. This piece was presented by the firm, at the close of the Exhibition, to the ceramic department of the National Museum, and is now on one of the walls of the Smithsonian. The Paris Exposition gave evidence of an increasing interest in this form of wall decoration.

Tiles are now extensively used for decorating furniture and stoves, for flower boxes, and for the jambs of grates and

Sizes of British tiles for boxes and jambs. mantels. With British manufacturers 6x6″ square is the size in most common use. Four of these make one square foot of surface. But 5x5 and 3x3 inches are also made,

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and borders to correspond. The following table shows the range of sizes for plain, unglazed tiles: *Tiles.*

Squares.—		Bands.—	
6 x6	inches.	6½x3½	inches.
5 x5	"	6½x1½	"
4½x4½	"	6 x4	"
4½x4½	"	6 x3	"
4 x4	"	6 x2	"
3½x3½	"	6 x1½	"
3 x3	"	6 x1½	"
2½x2½	"	6 x1	"
2½x2½	"	4½x2½	"
2½x2½	"	4½x1½	"
2 x2	"	4½x1 1/16	"
1½x1½	"		
1½x1½	"		
1½x1½	"		

Ranges of sizes of plain British tiles.

Of each of these sizes there are diagonal halves and quarters, also octagons, hexagons, pentagons, lozenges, and other regular geometrical shapes. The very small tiles or "tesseræ" range from 1/16x1/16" to 1x1" and are used in mosaic work. There are larger sizes of the enameled, ornamental, and the majolica tiles. The largest of the former are 12x12"; 9x9" and 8x8" are also made, besides 8x4", 7x7", 6x6", 6x3", 6x2", and 6x1". Shapes of tiles. Sizes of decorated and enameled tiles.

The tiles in France, and on the Continent generally, are made in fractions of the meter, and are larger than the 6" tile. The Dutch tiles measure 5¼x5¼", and are less than half an inch thick. The old Saracenic and Persian tiles are generally larger, being nearly one foot square. Continental sizes.

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Tiles

Cambell Brick and Tile Company.

CAMPBELL BRICK AND TILE COMPANY.

Exhibits.

The Campbell Brick and Tile Company, of Stoke-upon-Trent, England, exhibited a fine assortment of encaustic and geometrical tiles and mosaics, suitable for churches, public buildings, halls, vestibules, conservatories, etc.; also majolica, glazed, and other tiles for hearths, fire-places, baths, walls, etc. There was also a series of enameled and earthenware tiles from Minton's china works.

Reproductions of mediæval tiles.

Among the novelties we note superior reproductions of the ancient mediæval tiles, with the pitted irregular surface peculiar to them. The "newness" of the reproductions is completely disguised, and they may now be used in restorations without the tell-tale contrasts before observable between the old and the new.

Morocco surface tiles.

The morocco or leather surface tiles have been carried to great perfection, and were shown in a variety of tints.

Mantel adorned with plaques in *grafito* by Solon.

A novelty was presented in a large mantel made for Mr. Campbell, the proprietor of the works, and adorned with a series of large flat plaques, rectangular and tile-like, on which M. Solon has executed figures emblematic of ceramic industry in various countries. These designs are in *grafito*, being incised in a thin layer or covering of white slip over a dark-red colored, coarse, clay body. It is a process almost the reverse of the *pâte-sur-pâte*. The figure is outlined by a sharp steel point and then for the background and shadows the slip covering is scraped away. The design is thus left upon the surface in flat relief, being a mere film not much thicker than a card. The whole surface is then enameled with a fusible lead glaze, which incorporates itself with the body and slip and gives a mellow softness and finish to the work.

Nature of the *grafito* process.

Description of the plaques.

The nature of these tiles will be better understood by the aid of the accompanying illustrations from photographs presented to me by Mr. Campbell. Each tile or slab is 18″ long by 9″ broad, except two square tiles in the jambs, each about 15″ square; on one of these square tiles, a group of flying cherubs, in mid-air, is turning a potter's wheel, while two Cupid potters above, suspended by ropes, are modeling a vase. Below are pots and vases of various forms ready for the kiln. In each corner a bunch of potter's tools is suspended.

The companion tile on the other side of the mantel represents the process of firing or baking potter's ware. Cupids are flying to and from the kiln, bearing the ware, while a

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Tiles

Cambell Br and Tile Co pany.

Exhibits.

Reproducti of mediæval til

Morocco s face tiles.

Mantel adorn with plaques *grafito* by Sol

Nature of t *grafito* process

Description the plaques.

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PLATE 12.

GREECE.

(Grafito tile by Solon.)

Figure with Grecian vases of characteristic forms.

[Page 210, vo'. III.]

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PLATE 24.

EGYPT.
(Graffito tile in Sabouraud.)
Figure holding a pair of vases.

(Page 230, vol. III.)

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PLATE 13.

EGYPT.
(Grafito tile by Solon.)
Figure holding a pair of vases

[Page 210, vol. III.]

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PLATE 14.

PERSIA.

(Grafito tile by Solon.)

Figure in Persian costume, with large round plaque decorated in Persian style.

[Page 210 vol. III.]

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A GEORGIAN SAXE-GE POTTERY
A Large Tile by Sabou

(Page [illegible])

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PLATE 15.

CHERUBS MAKING POTTERY.
(Grafito tile by Solon.)

[Page 210, vol. III.]

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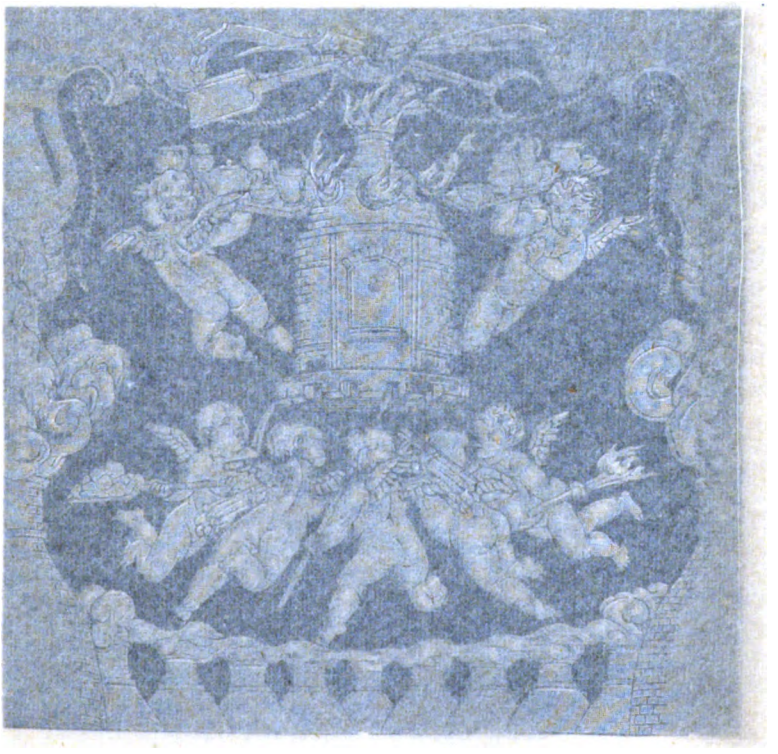
PLATE [illegible].



[illegible] FIRING [illegible]
Graduto tile by [illegible]

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PLATE 16.

CHERUBS FIRING POTTERY.
(Grafito tile by Solon.)

[Page 210, vol. III.]

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group below is firing the furnace by coals, faggots, and torches. *Tiles.* Campbell Brick and Tile Company.

There are ten of the oblong tiles, indicative of the pottery or characteristic ceramic products of England, France, Germany, Italy, Morocco, China, Japan, Greece, Egypt, and Persia. These emblematic figures are shown in the plates accompanying this report. Solon plaques.

The carving of this mantel was executed by J. E. Knox, and all of the tiles by M. L. Solon, in 1878, as stated on a grafito tile at one end of the mantel. J. E. Knox,

MINTON, HOLLINS, & CO., STOKE-UPON-TRENT. Minton, Hollins, & Co.

This firm made a large and beautiful exhibition of the encaustic and enameled tile and mosaics of their manufacture. These tiles have long been well known and extensively used in the United States. The following notice is from a report by the writer, made after the Vienna Exposition in 1873:

"The manufacture of encaustic tiling was commenced in 1840 by Mr. Herbert Minton, and is now carried on by Mr. Hollins in a new establishment, built upon the old site at Stoke-upon-Trent. The business has increased enormously. Aside from the ordinary demand for paving-tiles, there is a constantly increasing consumption of plain white tiles for stables, sculleries, closets, walls, etc. The plain white glazed tiles are sold at the works as low as 2½*d.*, equal to about 5 cents each; and, considering how superior they are to any other material, perhaps not even excepting marble, for facing walls which it is important to cleanse often, the large consumption is not surprising. But the demand has also increased enormously for the encaustic and ornamental tiles, owing not only to the greater number exported to the United States, Australia, and other countries, but to the more general appreciation and increased use of them in England. History of the works.

"The great expansion of the industry required increased facilities for the manufacture, and led Mr. Hollins, now the chief owner and the manager, to erect new buildings specially arranged for the rapid and economical manipulation of the large quantities of material. By the courtesy of Mr. Hollins, I was allowed to inspect the whole establishment, and to see every detail of the manufacture. It may be considered a model. The clays are landed at a commodious wharf on one side, and the finished goods are delivered on the other side. The movement of the materials is in *one* direction, forward from the clay heaps, through the mixing and molding rooms, to the furnaces, and from the furnaces Increase of facilities.

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Tiles.

to the packing rooms, without carrying back and forth.

Minton, Hollins, & Co.

The materials are selected and combined with great care, so as to insure the greatest possible strength and perfection in the product.

Materials.

For the red tiles and the buff tiles clays are obtained in the vicinity, and are remarkably well adapted to the purpose. The white body is formed of a mixture of the Cornish clays and calcined flint. As much care is taken in the preparation as is bestowed upon the manufacture of the body for stone china.

Enameled tiles.

The basis of the colored enameled tiles is equally white and strong. Skilled artists of reputation are constantly engaged in the decoration of slabs and large tiles for special purposes. The risk of breakage or distortion of the large slabs in the successive firings to which they must be submitted is so great that they are now usually made in three or more parts or tiles, and are fitted together after the last firing.

FIG. 8.—*Tile Panel; Minton, Hollins, & Co.*

Encaustic tiles.

"Great labor is expended upon the finer qualities of encaustic tiles. They are made chiefly by hand, of moist clay, and are finished by scraping. Such tiles cost from 1*s.* to 2*s.* 6*d.* each, and are too costly for general use.

Kilns.

"Eleven or twelve large kilns are required for the burning. An engine of 60 horse-power suffices to do the grinding and mixing of the materials. An average of 700 persons is employed."

Specimen of mosaic work at Washington.

A fine specimen of the mosaic work of this establishment may be seen in the museum at Washington, in the form of a panel for a reredos, presented at the close of the Centennial Exhibition to the museum by Mr. Hollins.

Maw & Co.

MAW & CO., BROSELY, ENGLAND.

The firm of Maw & Co., of Brosely, is also a large manufacturer of encaustic and enameled tiles and of art tiles for mural decoration. Their tiles are also well known in the United States, and are largely used.

Wall tiles.

Wall tiles.

Barluet & Co.

BARLUET.—The mural tiles of Barluet & Co. have already been noticed in the description of the exhibits by the firm.

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It is a great work, covering one end of one of the wings of the fine art department. It is a fine example of bold execution and impasting of enamel colors. The tiles are each $7\frac{3}{4}''$ square.

Tiles. Barluet & Co., Paris.

Stove tiles.

Tile stoves.

Delaisse, Paris, was the exhibitor of a variety of tiles and blocks for stoves and for tables, made of a red coarse clay, a brick-clay body, but covered with well-colored enamels or slips, and producing a pleasing effect. He also showed medallions in the style of Della Robbia, and had a very even-flowing good quality of blue and white enamel.

Delaisse, Paris.

In the Swedish section there were several very fine exhibits of tile stoves. The Rörstrand works sent some with unusually large open fronts, permitting the fires to be seen. One, in mediæval style, was fitted up with a pyramidal retreating back; price, 2,100 francs. Another stove, of cylindrical form, intended to stand out in the room, separate from the wall, was enameled light blue and gilt. One of the wall stoves was of black enamel.

Rörstrand works, Sweden.

The dimensions are given in inches, and the price in Austrian florins, equivalent to about 50 cents in currency. The price of packing ranges from 6 florins upward, according to the size of the stove.

Another very interesting display of stoves of this description, and particularly of the tiles in great variety, was made by Bernhard Erndt (court potter), Vienna, whose manufactory is in the IX *Besirk*, Rossau, Pramergasse, No. 25. The patterns of his tiles are peculiarly attractive, many being deeply recessed and enameled in bright colors—brown, green, blue, white, and variegated. The stoves and stove tiles made in Berlin are in high repute, and are even imported to Vienna. They are to be seen, among other places in that city, in the rooms of the Engineers' and Architects' Association.

Bernhard Erndt. Vienna.

Berlin stoves.

It is evident that the manufacture of "porcelain stoves," the tiles for them, and the fitting, constitute important branches of industry in the German-speaking countries. Such stoves, especially as now made, and susceptible of further improvements, have many great advantages over other heating apparatus, and might be introduced with success in some sections of the United States. The following are some of their merits, as compared with the ordinary cast or sheet iron stoves for heating apartments:

Porcelain stoves an important industry in Germany.

1. Not being good conductors of heat, they radiate it slowly and without sudden changes; and being bulky, they

Merits of the porcelain stove.

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Tile stoves. retain heat for a long time, and maintain an equable, moderate temperature in the apartment, even long after the fire has burned out.

Advantages. 2. They do not scorch and "burn the air," or the floating particles of dust in it, as is the case with highly-heated metallic stoves.

3. They combine to a great degree the advantages of an open fire-place and of a stove, giving ventilation, permitting the fire to be seen, while most of the heat is utilized, being stored up in the mass of the tiles and slowly radiated. Doubtless such stoves would fail to satisfy those who require a red-hot surface, superheated air, and little ventilation; but many improvements might be made, so that all the heat which wholesome conditions require could be obtained without difficulty and with great economy.

Austrian tile stoves.

J. de Ceute, Vienna.

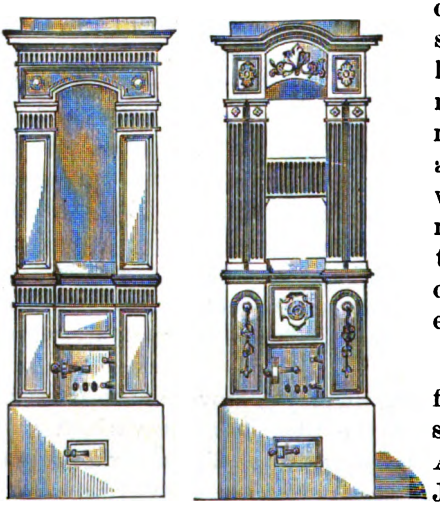

FIG. 9.—*Porcelain stoves. Joseph de Ceute, Vienna.*

The accompanying figures are from the designs exhibited in the Austrian section by Joseph de Ceute, of Vienna, but give only a faint idea of the variety and beauty of the stoves which he manufactures. The lower and broader forms are from 4 to 5 feet across the front, and much resemble the modern low mantels for grates. The fittings in front, to close the openings, are of brass, highly polished. The exhibitor gives the following schedule of prices for the ordinary sizes of stoves, gray and white, delivered at the establishment in Vienna:

Prices of tile stoves.

Height, inches.	Breadth of of base, inches.	Price in florins.		Height, inches.	Breadth of of base, inches.	Price in florins.	
		Gray.	White.			Gray.	White.
61	18	35	38	74	26	80	90
65	20	42	45	78	26	90	100
68	22	50	55	82	28	100	120
72	24	60	65		30	120	140

In the Austrian section there were also examples of tile stoves, in the production of which the Vienna manufacturers excel. I may be permitted to reproduce here some

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of the notes upon Austrian stoves made at the Vienna Exposition of 1873: *Tile stoves.*

"The so-called 'porcelain' or German stoves, familiar to those who have resided in Germany, Austria, or Hungary, were extensively exhibited in the Austrian and Prussian sections. The material is not porcelain, but earthenware, molded into tiles or hollow bricks about 6 or 8 inches square and several inches thick. They are made in a great variety of ornamental forms, and are generally glazed on the outer or exposed face, either white—which is most common—or brown, red, green, or black. Besides the ordinary flat-faced tiles, they are made with incised or raised designs, or are molded in high relief, so that when combined they form recessed panels or projecting fillets and moldings, in a variety of architectural patterns. *German stoves.* *Colors.* *Architectural patterns.*

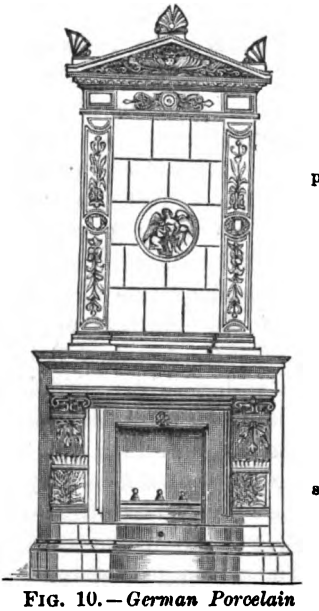

FIG. 10.—*German Porcelain Stove.*

"The back portion of the tile exposed to the fire or heated gases rising from it is perforated and peculiarly shaped, so as to expose a large surface and make a series of tubular openings favorable to the absorption of the heat in the body of the tile.

"The shape of the stove formed of these tiles varies with the taste of the fabricant and the demands of the consumer. They are generally from 6 to 8 or 10 feet high, with a breadth of 3 or 4 feet. Usually there is a deep recess above the fire-space, or an opening quite through, the stove being divided in that portion into the parts united above by an entablature and cornice. Cylindrical or columnar stoves are also made; indeed, the modifications are numerous, to conform to the varying taste or fashion of the time. Lower and broader stoves are now coming into use, with large openings in front, so that the fire may be seen and enjoyed as in an open fire-place, while the heat is much better utilized."* *Varieties and sizes.* *Open fronts.*

Fire bricks. *Fire bricks.*

GLENBOIG FIRE CLAY COMPANY, GLASGOW, SCOTLAND. Glenboig Fire Clay Company.

The products of this establishment, located near Coat-

[*From "Ceramic Art," by William P. Blake. Van Nostrand, New York.]

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Fire bricks. Glenboig Fire Clay Company. James Dunnachie.

bridge, Scotland, were shown in profusion, and received an award.

The manufacture is carried on by Mr. James Dunnachie, who is well known to those using fire brick extensively, and also as the author of a very interesting paper on the manufacture of fire brick, read at the meeting of the British Association for the Advancement of Science, held at Glasgow in 1876. The bricks made at these works are such as are used for Siemens' patent regenerative gas furnaces, forge and rolling-mill furnaces, puddling furnaces, and steel furnaces; also for copper calcining, roasting, and refining furnaces, gas retorts, etc. The exhibit also contained samples of tuyeres for Bessemer converters, stoppers, nozzles, etc.

Use in metallurgical furnaces, converter-tuyeres, etc.

Qualities of a first-class fire brick.

It is claimed for these bricks that they are unequaled for the construction of furnaces subjected to the most intense heats and sudden changes of temperature. Mr. Dunnachie stated at the Exposition that the peculiar qualities of the brick were best illustrated by taking as an example a forge furnace doing heavy work. The qualities required in a fire brick for such a purpose are: 1st, no melting; 2d, no cracking and spliting off; and, 3d, high heat-resisting power, so that the heat may not be passed easily through the crown and sides, but may be thrown back into the furnace, thus retaining the heat produced. In other words, good fire brick should be infusible, not liable to split or fly into pieces in the fire, and good non-conductors of heat. All these qualities are claimed in a high degree for the Glenboig brick, and the numerous testimonials sustain the claim. It is stated that in the furnace the bricks wear or "sweat away" slowly. The wasting away taking place only on the surface exposed to the heat, the body of the bricks remaining as rough and porous as when first laid. It is stated also that these bricks, when heated, as in an iron-forge furnace from which the iron has just been removed, will bear a deluge of cold water from a hose pipe without cracking.

Durability.

As the paper read by Mr. Dunnachie has great practical value to the maker and the consumer of fire brick, and as I have been kindly furnished with a copy of it, I introduce it entire:

Fire-brick manufacture.

*Manufacture of fire bricks.**

"The fire-brick question may be viewed from various sides. The owner of furnaces who uses the bricks, the man of science who has to do with their chemistry and other technicalities, and the brick-maker who manufactures them, may

* A paper read at the meeting of the British Association held at Glasgow September, 1876, by James Dunnachie, Glenboig.

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each have something to say on the subject. In the present paper we will view it from the brick-maker's standpoint, and will strictly confine ourselves to that branch of the fire-clay trade indicated by the title. *Fire bricks.*

"The iron and steel manufacturer, who may be taken as the representative of furnace owners, has, in various ways recently, shown a deep interest in this subject. In the iron-trade journals of this and other countries it bulks up as one of the pressing questions, and at the last three meetings of the Iron and Steel Institute it has been under discussion in connection with a paper read by Mr. Snelus, of the West Cumberland Iron and Steel Company, which will be found published in the Reports of the Institute for 1875 and 1876 These discussions are valuable, being the latest utterances of some of our first scientific and practical men. Interest of the metal-worker in the subject

"The metal smelter observes that his furnaces, unlike his other buildings, are continually melting and crumbling away. He is steadily increasing the magnitude of his operations and the intensity of his heats, and finds his progress arrested by the weakness of his furnace materials. The tear and wear has increased until it has become a serious item in the cost of production, and for this he naturally seeks a remedy; hence the demand for cheaper and better fire bricks. How, then, is this to be attained? Are we to wait till we stumble upon something, or may we expect to be guided by chemical science? Some practical men have no faith in analysis as indicating the true character of fire clays. They find that mere analysis does not reveal all that requires to be known, and that its results are not enough until confirmed by the practical test in the furnace. Still, the chemist may and does guide us to that which gives the highest probability of success, and, if ever the other qualities, not revealed by analysis, are to be accurately observed and their values determined, it will probably be the chemist who will do it. It is pre-eminently a chemical question, not for analysis merely, but that every peculiarity of form, proportion, relationship, and general conditions may be carefully and accurately observed, and data established which will give us something to aim at and something to guide us in our every-day practice as manufacturers. Much has been done already, and there are indications of an increasing chemical interest in the subject, which, with the co-operation of the consumers and manufacturers of fire bricks, may ultimately lead to results that will meet all the wants of practical metallurgy. The smelter's need of durable furnace materials. Chemical indications.

"Silica, alumina, bauxite, carbon, magnesia, lime, are all highly refractory, the two first-named (silica and alumina) Refractory materials.

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Fire bricks.

being the essential constituents of our fire clays. Lime and magnesia, though practically indestructible by heat, fuse easily when combined with silica, and are consequently classed with oxide of iron, potash, soda, etc., amongst the impurities of fire clay. Experiments are at present in progress with several of the ingredients named, and important results are expected in more directions than one.

Consideration of materials.

"The great variety of purposes for which fire bricks are used, and the various, and even opposite, qualities required in them, makes it impossible that one brick can answer for all descriptions of furnaces. They require to stand strong heat, change of temperature, in some cases heavy pressure and hard knocks, and also fluxing and chemical action of various kinds. For all these purposes we require not one but a variety of bricks, and this variety we will probably find sooner or later in the different refractory substances at our disposal.

Different qualities of bricks for different purposes.

"The age of a fire brick depends upon the purpose for which it is used; in some situations it may be counted by minutes, in others by years; and some bricks will last for years in positions where others also bearing the name of fire bricks would be destroyed in as many weeks.

Age of a fire brick.

"The name fire clay covers a multitude of qualities, and fire bricks differ to such an extent chemically, and as manufactured articles, that if their names were to indicate their qualities, rather than the general purpose to which they are put, a great many new names would require to be invented.

Differences in clay.

Although no one brick answers for all purposes, a great deal can be done in the process of manufacture to fit it for the particular use to which it is to be put: one requires to be solid and close bodied, another porous and open; in certain special cases soft burning is preferred, while in others they cannot be too hard. As a general rule, fire bricks should be hard burned. The shrink from the green state to the burned condition is generally about one-twelfth of the bulk; and if this is not entirely reduced in the kiln some of it will require to be burned out after the bricks are built in the furnace, and this must injure its stability.

Adapting to specific uses.

Shrinkage.

"Mixing clays of different kinds has been recommended, with the view of combining the good qualities of each, and more especially to increase or diminish the relative proportion of silica. This may do good in some cases, but, as fire clays have their bad qualities also, mixing will, in many cases, increase the force of these, and so do more harm than good. Riley says, touching this point: 'In considering the qualities of a fire brick chemically, the bases that have a

Mixing of clays.

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Fire bricks.

fluxing action should be considered as a whole. A brick might contain more oxide of iron than it should do, yet on account of its being free from other bases it might, nevertheless, be a good brick.' We thus see that the number of the objectionable ingredients has something to do with the result; besides, a natural chemical combination and an artificial mixture might give the same analysis and yet be very different when made into bricks and put to the practical test.

Kind and proportions of impurities.

Natural and artificial combinations and mixtures.

"Those containing the largest percentage of silica, if otherwise pure, stand best in the highest heats, but are liable to split up by sudden heating or cooling. A brick high in silica, yet containing a fair proportion of alumina, and comparatively free from alkalies and other impurities, is the one which combines, in the highest degree, infusibility and freedom from splitting, and is, consequently, found to be best suited for all such purposes as puddling, rolling, and forging, and the Siemens regenerator, where the great desideratum is precisely the combination of these qualities. A sample of clay from the Glenboig Star Mine was recently analyzed by Riley, and, after being calcined, gave the following result:

Predominance of silica.

The composition and behavior of a first-class brick.

Silica	65.41
Titanic acid	1.33
Alumina	30.55
Peroxide of iron	1.70
Lime	0.69
Magnesia	0.64
Potash, with a little soda	0.55
	100.87

Analysis of Glenboig Star Mine clay.

"To get a really good furnace we must first procure the best materials for its construction, but after that much depends upon how it is built. If we were as careful about the lines of our furnaces as we are about the lines of our ships, and as particular about the quality of the materials and workmanship employed as the importance of the subject demands, we might in many cases double the duration of our furnaces, without waiting for the possible discoveries of the future. However anxious we may be for some radical improvement, in the mean time we must make the most of the materials we possess, and of our present knowledge of the modes of manipulation.

Care in furnace building.

"The making of a fire brick is like the making of a pin—the article looks a simple one, yet the process is complex and somewhat elaborate. Some of our most ingenious machines have intelligence put into them at the beginning, and are afterwards almost self-acting; and while this can be

Complex conditions of fire-brick making.

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Fire bricks. done, to some extent, in setting down a new fire-brick work, still, in no other manufacturing process is close and careful attention more essential if the best results are to be obtained. As in scientific investigation the smallest gleam of truth has its value and its place, so in the workshop every little bit of ascertained fact has its value also, and if it gets its place it will certainly bring its reward in the general result.

Fire-brick trade of Glasgow. "The fire-brick trade of Glasgow cannot lay claim to the antiquity which belongs to Stourbridge or Newcastle. It only dates back some forty or fifty years, when it was first started at Garnkirk, and is therefore comparatively young. But it is healthy, and even already well grown. For years past it has entered into friendly rivalry with the older seats of the manufacture, and found markets in all parts of the world, and notably in the northern and midland counties of England, to which districts one or two of the best brands are sent in large quantities.

Quantity made per annum. "The quantity of fire bricks made in the Glasgow district, which is almost exclusively comprised in the counties of Lanark, Renfrew, and Ayr, amounts in ordinary times to eighty millions. In addition to this there is manufactured an enormous quantity of sanitary pipes, gas retorts, and other articles in fire clay, both useful and ornamental. Considerable quantities of fire bricks are also made in the neighborhood of Edinburgh and in the counties of Sterling and Fife; but these I have not the means of estimating.

Other fire-clay articles.

Geological position of the Glasgow fire clay. "The fire clays wrought in the neighborhood of Glasgow are situated, geologically, in the upper coal series and limestone series, taking the Roman cement as the dividing line, or, according to the ordnance geological map, in the millstone grit. They are found at all depths, from the surface open cast workings to pits of 40 or 50 fathoms. They are sometimes taken from lower depths where coal is being wrought; but we do not find our best qualities in such positions. The workable seams vary in thickness from about 3 feet to 30 or 40 feet. The process of fire-brick making is pretty much alike all over the West of Scotland, and indeed everywhere else when fire clay is the material employed; but, as it is necessary to be clear and connected, we will follow the process as applied at the Glenboig Star Works, near Coatbridge. The clay is there found 113 feet deep, and varies in thickness from 6 to 9 feet. In descending the shaft we pass through from 12 to 20 feet of floating whinstone (the overflowings of the numerous trap dikes which intersect the strata of the district): this covers a consider-

Workings.

Star Mine.

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Fire bricks.

able part of the Glenboig field. Under the whin are numerous beds of fire clay and siliceous rocks, some of them almost pure silica of the true ganister type. The system of mining is what is called stoop-and-room, or pillar-and-stall. The workings are 12 feet wide and the stoops left in are 30 feet square, excepting at the pit bottom, where they are much larger. The stoops may be cut through, and, when the proper time comes, removed altogether. The clay in its natural state is very hard and requires to be blown down with gunpowder. The clay is sent out in pieces about the size of good round coal. It is raised to a high pit-head platform, from whence it is run either to the crushing mills direct or to the bing where it is exposed to the action of the weather.

System of working.

Weathering and milling.

"When weathering is adopted the extra labor of lifting and laying is involved; but the ease with which the milling is afterwards effected fully compensates. When the clay is mixed with 'bullets' or nodules of iron, or any other visible impurities, weathering permits of these being picked out. It also disintegrates and softens the clay, so that a much solider body and smoother surface can be given to such articles as require these qualities.

Open grain desirable.

"In bricks for general furnace purposes we do not want a close texture. The brick must have sufficient flour in it to give it toughness and strength, but, that accomplished, our aim is to make it as rough and open in the grain as possible, that it may be the better able to resist high and variable temperatures.

"The crushing and milling are effected by means of revolving pans, in which heavy iron-edge rollers run. The crushing pan is 7 feet in diameter and perforated in the bottom; the crushing rollers weigh upwards of 3 tons each. The wet pans are 6 feet in diameter and the rollers weigh 35 cwt. each. They receive their motion from a large shaft running overhead, connected with the fly-wheel of the engine.

Crushing pans.

Milling pans.

Breaking and milling.

Process described.

"The clay is first broken with hammers and shoveled into the crushing mill. The bottom of the pan has rows of perforations through which the clay is crushed. Scrapers attached to the pan beneath throw it into an iron box, from whence it is lifted about 20 feet by means of an endless chain fitted with elevator buckets, which deliver it into a cylindrical riddle 8 feet long and 2½ feet in diameter; this is so placed that the riddled-clay drops to a second set of elevators, while the pieces too large to pass through drop back into the crushing mill. This second set of elevators

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Fire bricks. has two duties to perform: it either sends the fine ground fire clay which is used as mortar in furnace building to an endless belt, which carries it to the wagons on the railway outside, or the rougher brick clay to the tempering pans by means of a box 60 feet long, placed overhead. In this box there is a traveling chain fitted with cleats, by means of which the clay is dragged along. In the bottom of the box are four holes to which four conductors are attached, one to each mill. These, from their position, are always kept full, and when the millman requires clay he has only to draw a sluice at the lower end of the conductor, and the clay drops into the pan. He then turns on the water, and the mill is charged in a second or two.

Tempering pans.

Sieves. "For mortar clay a comparatively fine riddle is used, and for brick clay one of a coarser kind. In preparing clay for glass-house blocks, gas retorts, Bessemer tuyeres, and all large articles, a proportion of previously burned bricks or clay is added, to prevent cracking in the drying. Pug-mills are generally employed for tempering where the clay is of a soft aluminous nature, but they are not suitable for hard, gritty, silicious clays, such as are used at these works. When ready for molding, the clay is discharged into small tipping bogies, which are raised by means of a steam hoist to the upper floor of the drying stove. It is there run along a little railway, from whence it is dropped down through suitable openings to the molders' benches. By this method one man delivers the clay to nine or ten molders. It has also the advantage of taking the traffic off the drying floor.

Pug-mills.

Hand-molding. Once in the molder's hands, it is rapidly turned into bricks. A good workman with his carrier will make 2,500 bricks a day.

Solid brass molds. "Solid brass molds are used for regular sizes, but for odd kinds and the larger sizes wooden molds are employed. Iron, zinc, and glass have been tried, but hard brass has many advantages. The molds are made a twelfth larger than the size of the burned brick, to allow for shrinkage. The face-board on which the brick is made is covered with thick 'plaiding,' and the trade-mark is fixed upon it, so that making and stamping are performed in one operation.

Molding machinery. Machinery is successfully employed in molding common building bricks from stiff plastic clay, and also in the manufacture of dry or semi-dry compressed bricks from various materials; but no machine has yet been made capable of taking well-milled fire clay as it leaves the pans, turning it rapidly into bricks, and delivering them square and sharp-

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edged on to pallet-boards, from whence they can be set on the drying floor. *Fire bricks.*

"When the brick is molded by hand the molder discharges it on to a pallet-board, the carrier then places another board on the top of it, and between the two the soft brick is carried with safety and deposited on edge on the stove floor, where it remains till hard and dry, when it is taken to the kiln. Molded bricks carried between pallet-boards.

"The defects most common in fire bricks, with the exception of soft burning, are produced in the stove, and it is here alone that soundness and finish can be given to them. If the stove floor is uneven, the shape of the brick is spoiled; and if too much heat is applied, the bricks are warped and cracked. Some clays are very liable to crack when too quickly dried; and where stoves are badly constructed, this occasions loss, and injures the quality of the brick to a serious extent. Where some are cracked through, others are partially cracked, and so on through all the stages of cracking, up to the sound ringing brick. Bricks of this description give also increased breakage in the kiln, and indeed in every stage of their existence. Defects produced in the stove or drying floor.

"To meet all this, a recently patented construction of stove is employed. The stoves are 120 feet in length by 36 feet wide, and are fired from one end. The drying floors are entirely formed with cast-iron plates, each 4 feet by 2 feet, by $\frac{5}{8}$ of an inch. These are smooth and easily heated. Underneath the iron floor there is another half floor formed of fire-clay slabs, 4 inches and 3 inches thick, which runs from the furnace end to the middle of the stove, a distance of 60 feet. The fires and hot flues are underneath the fire-clay slabs, and between the fire-clay slabs and the iron plates forming the upper floor there is an air space of 8 inches deep; this communicates with the outer air at the gable over the fires. Each flue has its own air space. By this means the stove may be fired up so as to heat effectually the back end, while too much heat on the furnace end is prevented by the current of cold air passing between the two floors, till it joins the lower flue at the middle of the stove, carrying with it the superfluous heat of the furnace end and utilizing it where it is required. Two such stoves, of the dimensions named, are turning out from 20,000 to 24,000 bricks a day. Every brick is ready for the kiln the day after it is molded. By this system of drying the cost is lessened, while the production for a given space is nearly doubled. Patent stove.

"Various other methods have been tried, such as exhaust steam in pipes or flues, and hot air, in a variety of ways. Experiments in heating the stove.

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Fire bricks. In such cases shelving is generally employed, and this entails extra labor and expense. The method just described is, in every respect, to be preferred, particularly where large production and perfect regularity are required.

Kiln. "When dry, the bricks are wheeled to the kiln, where they are built up in chequered walls, each brick being nearly an inch apart. A kiln contains from 16,000 to 20,000 bricks; when filled, the doors are built up, and the fires kindled.

Mode of firing. The firing is done very gently at first, the furnace being open, and also the holes in the crown of the kiln; this is continued for two days, till the damp is completely 'steamed' out of them, after which the crown of the kiln is carefully closed, the draught is connected with the chimney, and the kiln is put on full fire. This takes other two or three days, during which time it is steadily brought up to a bright white heat, at which it is maintained till the necessary sink in the bricks has taken place, after which the firing ceases, and the kiln is gradually cooled down.

Construction of kilns. "The kilns are built in pairs, back to back, and are fired from the one side across; the floor is not chequered excepting over the flue which runs along the back, and through which the draft passes on its way to the chimney, either direct or through another kiln. The fires are on the hopper principle, something after the style of the Siemens' producer. They are supplied with hot air heated under the floor of the kiln, and in addition there is a good-sized flue run from end to end of the kiln over the fires, through which cold air is

Flues for heating air. supplied to each fire. Without this flue the front of the kiln would become too hot; with it this is prevented, and the air thus introduced, after passing through the kiln, which acts as a kind of regenerator, combines at the back with the unconsumed gases, giving great evenness of burning and also great economy.

"The Newcastle kiln is the one generally used, and here and there the old Scotch or Leeds kiln is to be met with, but these are too expensive in times of dear coal.

"In conclusion, it may be asked, how are we to meet the want so frequently and urgently expressed for 'cheaper

Need of improved machinery and economy in fuel. and better fire bricks'? The introduction of improved machinery and more economical modes of using fuel may reduce the price, but suppose this could be done even to a considerable extent, and if after all the quality of the bricks should remain unsatisfactory, the want expressed would be

Improvement in quality rather than reduction of price. felt all the same. We are convinced that any substantial reduction in price must be sought in the direction of improved quality, so that the price, whatever it may be, will

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be found cheap, when viewed in relation to the service rendered. A superior raw material would do this most effectually, but in the absence of new and superior materials to work upon we must do all that science and practical experience have taught us to make the most of those at present at our disposal, and even within this narrower area a great deal can be done to improve the quality of our furnace bricks." *Fire bricks.*

Refractory ware. Refractory ware.

The firm of Doulton & Co., Lambeth, were also exhibitors of fire-resisting materials, fire brick, muffles, fire-clay retorts, furnaces, large perforated muffles, and crucibles. Also a great variety of forms of their terro-metallic brick. Doultons.

The excellence of the sanitary stone ware of this firm is well known and has been recognized by the juries at each of the successive great exhibitions, notably at Philadelphia in 1876, where there was a very complete assortment of sanitary and chemical stone ware. Sanitary stone ware.

American tiles. American tiles.

It is gratifying to note that since the Exhibition at Philadelphia in 1876 the manufacture of encaustic and of enameled tile has been successfully established in the United States. Encaustic tiles manufactured in the United States.

The American Encaustic Tiling Company (limited), New York, is now producing most excellent tiles, of various desirable colors, from clays in the State of Ohio, and have already filled many large orders for paving in public and private edifices, as will be seen from the accompanying list of buildings where their tiles have been successfully laid: American Encaustic Tile Co. Ohio clays.

Buildings where American tiles have been adopted.

St. Luke's Hospital, New York.
Bellevue Hospital, New York.
Chatham Bank, New York.
Sixth National Bank, New York.
The Brighton, Fifty-sixth street and Eighth avenue.
The Elise, Fifty-fifth street and Eighth avenue.
Chs. Bostwick, Fifth avenue and Sixty-first street.
B. Fischer, 227 West Thirty-seventh street.
A. Hupfel, Third avenue, corner One hundred and sixty-first street.
Dr. Henry Moeller, 240 West Thirty-eighth street.
Thalia Theater, New York.
Pope's Theater, Saint Louis.
Opera House, Zanesville.
Court House, Zanesville.
Court House, Indianapolis, Ind.
Produce Exchange, Toledo, Ohio.
Union Club House, Cleveland, Ohio.
Appraiser's office, San Francisco.
H. Brenkmann, bakery, Mott Haven.
Ph. & Wm. Ebling, brewers, St. Ann's avenue.

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American tiles.

An examination of these tiles by the writer has satisfied him that they are excellent in quality, even in color, dense, hard, and durable, and very true in form, permitting them to be rapidly and closely laid. The colors are also very desirable and are equal to the foreign.

WILLIAM P. BLAKE,
Mining Engineer, Honorary Commissioner,
Member of the International Jury Class 43,
Secretary of the Additional Commissioners, Paris, 1878.

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GLASS AND GLASS WARE.

WILLIAM P. BLAKE.

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[Extract from the Official Classification.]

CLASS 19.—CRYSTAL, GLASS, AND STAINED GLASS.

Drinking glasses of crystal, cut-glass, plated and mounted crystal, etc.; table glass, common glass, and bottles.

Window and mirror glass Cast, enameled, crackled, frosted, and tempered glass.

Glass for optical purposes, ornamental glass, etc.

Stained glass, mirrors, looking-glasses, etc.

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GLASS AND GLASS WARE.

The exhibition of glass, glass ware, and stained-glass windows, in fact all forms and varieties of glass for construction, table use, and ornamentation, was more complete and instructive than at any previous exhibition. The most ordinary forms of bottles of green glass and the most costly examples of cut and engraved crystal glass equally found a place in the gallery devoted to the display in the French section. The exhibits from other countries were confined more to the elegant and costly productions of the glass-maker's art. Next to the overwhelming display by the French, the Austrian section had notably the most brilliant and varied collection of decorated glass ware, made by Lobmeyer and drawn from various factories in Bohemia. The British section was more brilliant than heretofore in glass of unsurpassed purity of metal and superb cutting and engraving, sent by Thomas Webb & Sons, by Powell & Son, and other exhibitors.

Very complete exhibition of French glass.

Exhibits of other nations, principally of the finer varieties.

Austrian exhibits.

British excellence in flint glass, cutting, and engraving.

The manifold forms in which glass is wrought in Venice were fully represented by Salviati, Olivotti, and the Venice and Murano Company.

Venetian glass.

Number of exhibitors.

Number of exhibitors.

In the French section there were over 138 exhibitors, including those who exhibited stained-glass windows. In the British section there were 23 exhibitors; in the Austrian, 21; in the Italian, 20; from Spain, 3; Russia, 2; United States, 2.

LIST OF THE JURY AND OF THE AWARDS GIVEN IN CLASS 19.

CRYSTAL GLASS, GLASS WARE, AND STAINED-GLASS WINDOWS.

List of the jury.

List of the Jury, Class 19; Glass.

Messrs.	
BIVER	France.
LOBMEYR (L.)	Austria-Hungary.
DIDRON	France.
FORSTER GRAHAM, ESQ	England.
LE PROFESSEUR CAMPIERI (F.)	Italy.
LAMBERT	Belgium.
LE COMTE DE MATHIAN	Spain.
RICHARME	France.

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List of the Jury, Class 19; Glass.

Messrs.

MARIE.....France.
DUBOIS.....France.
MAËS (FILS).....France.
CLÉMANDOT.....France.

Awards, Class 19; Glass.

AWARDS.

GRAND PRIZES.

(Honorary diplomas equal to a grand medal.)

Grand prizes.

Verreries et cristalleries of Belgium.....Belgium.
Verreries et cristalleries of Bohemia.....Austria-Hungary.
Verreries et cristalleries of France.....France.
Verreries et mosaïques de la province de Venise.....Italy.

GRAND MEDALS.

Compagnie des Cristalleries de Baccarat.....France.
Webb (Th.) & Sons.....England.

Gold medals.

GOLD MEDALS.

Appert Frères.....France.
Baudoux (L.) et Cie.....Belgium.
Bernard et Cie.....France.
Bivort (H.-J.).....Belgium.
Camm Brothers.....England.
Compagnie Générale des Verreries de Venise-Murano.Italy.
Compagnie Générale des Verreries de la Loire et du Rhône.....France.
Compagnie Anonyme des Verreries et Cristalleries Namuroises.....Belgium.
Guilbert-Martin.....France.
Monot Père et Fils et Stumpf.....France.
Osler (F.) & Co.....England.
Oudinot.....France.
Pelletier et ses Fils.....France.
Société Anonyme de Floreffe.....France.
Société Anonyme des Glaces et Verreries du Hainaut, à Roux.....Belgium.
Société Anonyme des Manufactures de Verres à Vitres Cristaux et Gobeleterie de Bruxelles (usines de Sainte Marie d'Oignies et de Mariemont).....Belgium.
Société Anonyme des Verreries et Glaces d'Aniche...France.
Société Anonyme des Verreries de Portieux et de Vallérysthal.....France.

Silver medals.

SILVER MEDALS.

Aire and Calder Glass Bottle Co. (The).....England.
Alain Chartier et Cie.....France.
Anglade.....France.
Aubriot-Rousseau, Cuchelet, et Cie.....France.
Bagley Wild & Co.....England.

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List of awards, Class 19; Glass.

Baudoux (E.) ..... Belgium.
Bitterlin ..... France.
Brocard ..... France.
Brunfaut (Vve. de) ..... Austria-Hungary.
Capronnier (J.-B.) ..... Belgium.
Chagot et Cie ..... France.
Champigneulle (*rappel*) ..... France.
Collignon et Clavon ..... France.
Delille et Cie ..... France.
Deviolaine ..... France.
Dressler ..... Austria-Hungary.
Fogt et Lemaire ..... France.
Fourcault Frison et Cie ..... Belgium.
Geyling ..... Austria-Hungary.
Grandrut aîné (A. de) ..... France.
Gsell-Laurent (*rappel*) ..... France.
Hardman (J.) & Co (*rappel*) ..... England.
Hirsch ..... France.
Hodgetts, Richardson, & Son ..... England.
Inwald ..... Austria-Hungary. Silver medals.
Kessler ..... France.
Kilner Brothers ..... England.
Kostereff et Neveux ..... Russia.
Kossuch (J.) ..... Hungary.
Landier et Houdaille ..... France.
Lavers, Barraud, et Westlake ..... England.
Lefèvre (*rappel*) ..... France.
Lemaire Fréres ..... France.
Lémal-Raquet et Cie ..... France.
Lissaute et Cosson ..... France.
Mondron (L.) ..... Belgium.
Morel (A.) ..... Belgium.
Neuhauser (A.) et Cie ..... Austria-Hungary.
Nicod ..... France.
Powell (J.) & Son ..... England.
Radi (L.) ..... Italy.
Rasch (C.) (*rappel*) ..... Austria-Hungary.
Renard Père et Fils ..... France.
Salviati et Cie ..... Italy.
Schmid (J.-E.) ..... Austria-Hungary.
Schmid et Duhoux ..... France.
Simpson (W. B.) & Son ..... England.
Société Anonyme des Verreries de Charleroi ..... Belgium.
Société Anonyme des Verreries d'Hénin-Liétard ..... France.
Société Anonyme des Verreries d'Hirson ..... France.
Société Anonyme des Verreries Lourches ..... France.
Société des Verreries d'Épinac ..... France.
Steinheil ..... France.
Ullrich ..... Austria-Hungary.
Ward & Hughes ..... England.

Bronze medals.

BRONZE MEDALS.

Ahne (J.) ..... Austria-Hungary.
Aurora Glass Co. (The) ..... England.
Bazin et Cie ..... France.

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List of awards, Class 19; Glass.

Bay	France.
Boissière et Fils	France.
Bourgeois	France.
Bremard	France.
Brunetti	France.
Bruzewitz (Fr.)	Sweden.
Bucan et Dupontieu	France.
Buquet	France.
Bussolin (D.)	Italy.
Candiani (M.)	Italy.
Crétin et Cie	France.
Demidoff (Prince de San Donato)	Russia.
Dorlodot (L. de) et Cie (*rappel*)	Belgium.
Domont et Sauvageot	France.
Dopter (*rappel*)	France.
Édouard-Roulet	France.
Fouracre (J. T.) & Watson	England.
Gallé	France.
Grandrut (E. de)	France.
Grohmann et Cie	Austria-Hungary.
Green (J.) & Nephew (*rappel*)	England.
Guerner (Ve.)	France.
Guertler et Fils	Austria-Hungary.
Hazard	France.
Hérédéros de Valarino	Spain.

Bronze medals.

Jean	France.
Jenkinson (A.)	England.
Lambert (L.) et Cie	Belgium.
Lang (J.)	Austria-Hungary.
Leprevost	France.
Lévêque	France.
Lorémy et Rochet (*rappel*)	France.
Lorin	France.
Lucinge-Faucigny (Prince H. de)	France.
Marquant-Vogel	France.
Maugin-Lesur	France.
Michon (*rappel*)	Portugal.
Moser (H.)	Austria-Hungary.
Muelhaus et Cie	Austria-Hungary.
Nyssens et Cie	Belgium.
Olivotti (T.)	Italy.
Ottin	France.
Parmentier et Cie	France.
Petit	France.
Pitman & Cuthbertson	England.
Queynoux	France.
Reyen	France.
Schmidt, Devillez, et Cie	Belgium.
Schmidt Frères et Sœurs	Belgium.
Société des Verreries Nationales, à Jumet	Belgium.
Société de Marinha-Grande (*rappel*)	Portugal.
Société des Glaces de Courcelles	Belgium.
Société des Verreries Réunies de Boussu-lez-Mons	Belgium.
Société des Verreries de Jemmapes	Belgium.

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List of awards, Class 19; Glass.

Bronze medals.

Société des Verreries de Marchienne-au-Pont (*rappel*) ..... Belgium.
Taylor (W. G.) ..... England.
Tumbeuf neveu et Neveu ..... France.
Verrerie de Vallô ..... Norway.
Villaume ..... France.
Wagner (P.) ..... Austria-Hungary.

HONORABLE MENTIONS.

Honorable mentions.

Baulard ..... France.
Becker ..... France.
Bedendo (D.) ..... Italy.
Benda ..... France.
Boirre aîné ..... France.
Boucher ..... France.
Bourières ..... France.
Bouvy ..... Holland.
Brasseur (N.) et Cie ..... Belgium.
Britten's Patent Glass Co ..... England.
Bruin ..... France.
Buglet ..... France.
Carpentier ..... France.
Casset-Delas ..... France.
Catherine ..... France.
Chabin ..... France.
Chateteau ..... France.
Compain ..... France.
Constable (W. H.) ..... England.
Coyen ..... France.
Craene (P. de) ..... Belgium.
Dobbelaere (H.) ..... Belgium.
Dandois ..... France.
Daniel (A. B.) & Son ..... England.
Delalande ..... France.
Dewez ..... France.
Ély ..... France.
Ernie ..... France.
Fuchs ..... France.
Girardin ..... France.
Guenne et Gilquin ..... France.
Guernet ..... France.
Guilbert d'Anelle ..... France.
Hodin ..... France.
Holt (F.) ..... England.
Hörler et Fils ..... France.
Hucher et Rathouis ..... France.
Kuhliger-Bouret ..... France.
Martin (C.) ..... France.
Mathieu ..... France.
Meriden Flint Glass Works ..... United States.
Miellot ..... France.
Millar (J.) & Co ..... England.
Monnoyer Frères et Cie ..... Belgium.
Néret ..... France.

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List of awards, Class 19; Glass.

Olivieri (L.) ..... Italy.
Paillard ..... France.
Pannier-Lahoche ..... France.
Pfulb ..... France.
Pomès ..... France.
Ponsin ..... France.
Radius ..... France.
Reverdy (L.-F.) ..... Belgium.
Rousseau ..... France.

Honorable mentions.

Schick-Weiler ..... France.
Société Anonyme du Verre Trempé ..... France.
Soullard ..... France.
Tiercelin ..... France.
Tommasi et Gelsomini ..... Italy.
Trauffler ..... France.
Vantillard ..... France.
Verrerie de Bergen ..... Norway.
Vincent ..... France.
Weberbeck (F. et C.) ..... Italy.

COLLABORATOR.

HONORABLE MENTION.

Fox (contre-maitre chez M. Deviolaine, manufacturer of bottles) ..... France.

FRANCE.

FRANCE.

The official introduction to the class divides glass products under eight different heads:

Flint glass.

1. "*Cristaux*," crystal glass (flint glass), for table services; lusters, candelabras; the crystal glass of luxury and of fancy, cut and colored, threaded, gilded, and painted.

Table ware, etc.

2. "*Gobeleterie*," fine and common, for table use; articles for restaurants; bottles for gaseous or aërated waters; retorts, and other apparatus for the laboratory.

Plate glass.

3. "*Les glaces*."—Mirror glass, plate glass, window glass; colored glass for pavements; apparatus for light-houses; rough glass, channeled glass; glass for roofs and covering plant-houses.

Window glass.

4. *Les verres à vitres*.—White and colored window glass; cylinders and globes; oval and square glass tiles.

Bottles.

5. Wine bottles; bottles for mineral waters; bell-glasses; convex glasses.

Enamels.

6. Enamels in mass, and tube glass for jewelry and enameling.

Mirrors.

7. Mirrors.

Stained glass.

8. Stained-glass windows.

The following tabular statement shows approximately the

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value of the annual production and exportation of glass of French manufacture: FRANCE.

	Production.	Exports.
	Francs.	*Francs.*
Crystal (flint) glass	11, 000, 000	4, 000, 000
"*Gobeleterie*"	14, 000, 000	8, 000, 000
"*Glaces*"	25, 000, 000	8, 000, 000
Window glass	15, 000, 000	3, 000, 000
Bottles	40, 000, 000	12, 000, 000

Production. Exports.

GREAT BRITAIN.

GREAT BRITAIN.

THOMAS WEBB & SONS, STOURBRIDGE.

Thos. Webb & Sons.

This firm exhibited a very great variety of table and decorative glass ware. The "metal," as the glass is called by glass-makers, was particularly clear and brilliant and of high refractive power, showing to great advantage in the heavily-cut ware and in the chandeliers. One novelty particularly worthy of mention, a heavily-cut service, had the appearance of being set with rubies in rosettes at the apex of the glass facets. They are, in fact, octagons of ruby glass, as perfectly cut as any gem, surmounting and firmly united with the brilliant crystal groundwork. They are the remnants of a complete coating of the surface by ruby glass, while the piece is in the molten state, the subsequent deep cutting removing all but the tips of the diamonds. A similar service, with blue glass, gives the impression of being jeweled with real sapphires. By the side of these a massive cut service, called the "Queen Anne," embodies the characteristics of the glass of the eighteenth century, harmonizing with the prevailing styles of furniture and decoration.

Brilliant flint glass.

Service with ruby studs.

Queen Anne service in cut glass.

Engraved and etched glass.

Engraved and etched glass.

This was shown in great profusion and beauty. It included many large and costly pieces, separately mounted as art objects, upon pedestals provided with the means of turning the vases around before the eye. These objects included designs by Mr. Pearce, but were mainly the result of the labors of Mr. O'Fallon, who has for years past made a special study of designing in its applications to glass. The firm spared no expense in having the designs of their artists fully worked out and embodied in whole services, characteristic of the decoration of different periods and countries. Thus, there were services of Egyptian, Celtic, Indian, Assyrian, Persian, Arabian, Greek, and Byzantine designs.

Pearce.

O'Fallon.

Services in various national designs.

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GREAT BRITAIN.

Thos. Webb & Sons. Parthenon vases.

Among the purely decorative objects were a pair of vases, each about fifteen inches high, upon which portions of the group upon the frieze of the Parthenon are copied by cutting in miniature—on one vase in intaglio and on the other in relief. Both are exquisitely cut, comparing well with the best ancient specimens of the glyptic art. Two years were required for the engraving. They are valued at about $2,000 each. There were several other good pieces, ornamented similarly by copies from Flaxman's illustrations to the Iliad and Odyssey. One two-handled vase, about twenty inches high, is a most elaborate work, representing Pluto and Proserpine in intaglio on the body of the vase, with Grecian and Pompeian ornamentation on the handles and neck.

Flaxman.

Classic vase.

Lustered glass.

Lustered or iridescent glass.

Lobmeyr.

Philadelphia, 1876.

This form of decorative glass, which was shown by a few examples by Lobmeyr in the Austrian section at Philadelphia in 1876, has now become very abundant and common. It has been made in great quantities of late, and it may be seen in the shop-windows in London, the small globes being generally filled with water to enhance the colored effect. The brilliancy of the iridescence has of late been perfected and increased, and it is most satisfactory when seen in shadow and not in full light. Chandeliers and decorative bulbous plates of this kind of glass are extremely brilliant. Even black beads for trimmings of ladies' costumes are now made as iridescent as peacock coal.

Bronzed glass.

Bronzed glass.

Process.

Next to this iridescent glass, and partaking somewhat of its character, is a new bronze glass, so called from its dark metallic appearance, like old bronze. It is a dark green glass, which has been subjected to corrosive vapors in such a way as to bring out the iris hues and give the appearance of great antiquity. This effect is enhanced by the classical shapes in which the vases are blown, reminding one at once of the ancient Roman glass of the museums. Viewed by transmitted light this glass is dark green, like glass colored by oxide of copper.

"Venetian" glass, onyx glass.

"Venetian" and onyx glass.

The production of glass in the Venetian style is not neglected by this firm. The characteristic forms and styles of decoration of the old Venetian makers are well represented. But the most satisfactory and attractive novelty of all is

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GREAT BRITAIN.

the onyx glass, in which we have the promise of a rapidly expanding and charming art industry, by which we can not only have good copies in form and material of the celebrated Portland Vase, but original productions in the same style. It is, in fact, a revival of the art to which we are indebted for the Portland Vase, which, as is generally known, is formed of glass—a dark glass for the body and a white opal glass for the raised figures overlying it, but all in one piece. To produce such vases it is only necessary to first envelop the whole surface of the vase with a thick coating of white or opal glass, and then to cut away, down to the groundwork or body of darker glass, all that is not required to form the raised figures. These figures are sculptured and engraved in minute detail by steel points used as gravers, as stone cameos are wrought out of the solid onyx. The effects are the same. Among the pieces so formed are exact reproductions of the Portland Vase and other specimens, notably the "Dennis Vase," designed and sculptured by J. Northwood. It stands about eighteen inches high, and the beautiful oviform body presents on one side the Triumph of Galatea, and on the other a copy of the Aurora of Guido. It is a beautiful object and the largest yet attempted. It is not yet finished. Two years' work has already been put upon it and it will require two more years of Mr. Northwood's best labor to complete it. A smaller vase, with the Aurora sculptured upon one side, is valued at $7,500.

Thos. Webb & Sons.

Onyx glass.

Portland Vase.

Process described.

Dennis Vase.

J. Northwood.

Engraved colored glass.

Engraved colored glass.

As closely allied to this method of manufacture, we may next mention the great variety of engraved colored glass now beginning to attract great attention by its beauty and comparative cheapness. Upon a groundwork of milk-white or opal glass thin coatings of blue and rose-pink glass are spread successively. The pink colors are especially remarkable for their delicate gradations and shades of color. A great variety of small objects for decoration are made in this manner. They are handed over to the engraver, who with his wheel cuts through the outer coats of color down to the groundwork of white glass. Extremely fine lines and delicate effects may be so produced. The process invites and requires careful drawing and skilled designing. This Mr. O'Fallon has not failed to appreciate, and most of the specimens are wrought from his designs. One in particular attracts attention, as representing the development of the tadpole into a full-grown frog; the successive stages

Process described.

O'Fallon.

Designs.

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GREAT BRITAIN.

Thos. Webb & Sons.

of growth being shown by a procession of tadpoles amongst aquatic plants. The completed frog stands upon a lily-pad, and seems to be announcing himself to the world in a burst of his peculiar eloquence. This material is well adapted also to diapered and geometrical designs. Some of this glass has already found its way to the United States, and is used chiefly for mounting in silver or plated ware.

POWELL'S GLASS.

James Powell & Sons.

James Powell & Sons, of Blackfriars, London, sent also some new styles of glass dinner services and decorative objects, in a peculiar olive green, in brown, and in opalescent glass, all of which were strikingly peculiar and attractive. They all show a great mastery of the art, and at the same time a good appreciation of the decorative requirements of the period.

ITALY.

ITALY.

The chief attraction was the unique display by the "Venice and Murano Glass and Mosaic Company, Limited," of 30 St. James Street, London, and 731 Campo San Vio, Venice.

VENICE AND MURANO COMPANY.

Venice and Murano Glass and Mosaic Company.

Founded in the year 1866.

This company was formed in the year 1866, by a few English gentlemen whose interest in Italian art induced them to subscribe the capital necessary to give a proper artistic and commercial direction to the revival of an industry for which Venice and Murano, in their palmy days, had acquired a world-wide celebrity.

It was not an easy task, for although the workmen retained certain traditions of the ancient art and methods, their taste had become vitiated by working from inartistic models, and time, patience, and special efforts were requisite to induce them to produce higher and more artistic types, more worthy of their intelligence and skill.

Signor A. Castellani.

Revival of ancient products.

Aided by Signor Alessandro Castellani, and by the fragments of some of the more remarkable ancient productions, which he carried with him and exhibited to the workmen, the company has been able to produce objects which compare with the best work of the ancient artists, and to reproduce some of the most celebrated objects preserved in the museums. Many of these precious objects were placed before the workmen by Castellani, and their ambition was at once aroused and stimulated. Their success in imitation and in working by the same methods is fully proved by the results shown in the cases of the company at Paris.

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ITALY.

The exhibit was arranged in chronological order, beginning with copies of early Roman and Christian glass from originals preserved in the library and in the Christian Museum of the Vatican at Rome, and including reproductions of Roman "murrhine" and vitreous pastes imitating agates, jacinth, sapphires, etc.; copies of Arab-Egyptian lamps, enameled; copies of early Venetian glass urns, tazzas, and nuptial goblets; enameled glass, glass mosaics, and marquetry work in glass, down to lusters, girandoles, and candelabra for modern theaters. A few, only, of the more interesting and important specimens will be noticed.

Copies of early Roman glass, etc.;

Of Arab and early Venetian objects.

In the collection of enameled glass there were vases, basins, lamps, and reliquaries, two of the latter in *enfumé* glass, enameled in colors and gold, with inscriptions in Arabic-Byzantine style, formed after an original in Mr. Castellani's collection, and the motive of the ornamentation from the fragment of a bass-relief found in the island of Torcello. There was also a nuptial goblet of sapphire color, enameled with figures and landscape, with medalion portraits of a young man and woman, representing nuptials of the fourteenth century. It is an exact reproduction of the celebrated *Coppa Nuziale* in the Corner Museum at Venice, the work of a Muranese artist of the fifteenth century. But the most interesting of all the reproductions is found in the

Enameled glass.

Nuptial goblet.

St. Mark's Tazza,

St. Mark's Tazza

an exact reproduction of the famous tazza in the treasury of St. Mark's, at Venice. It is blown in black glass, and is not over six inches high, but the original is valued at over 80,000 francs. This original was one of the treasured objects sent home to France by Napoleon I, but afterwards returned. For the purpose of making the copy, which is excellent, the original was borrowed of the government. The copy in black glass, like the original, is enameled in various colors and gold, and has round the circumference medalions and Coptic inscriptions divided into several zones. It is mounted like the original by Signor Castellani.

Copy in black glass with enamel colors and gold.

The original tazza is considered to be a work of the eleventh or twelfth century, and it is believed by some that the art of enameling, as practiced at Limoges, was started and stimulated by seeing this vase.

Copies from the Slade collection.

Slade collection.

The exhibit contained seventy different pieces, reproduced after specimens selected from among the best Muranese types.

Muranese.

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ITALY.

Copies of objects in the Murano Museum.

From the Murano Museum, also, there was a choice selection of fifty different *pièces*, exemplifying all the phases of manufacture in that island, including a large vase in opaline jasper and ruby glass, with two handles in the shape of swans, standing thirty inches high; a chalice, with cover in opal; and a large chalice, with cover of great delicacy.

Roman murrhine glass.

Roman murrhine glass.

Pliny.

In the beautiful collection of colored pastes, gem-like in color and brilliancy, there were cinerary urns, cups, *paterœ*, and goblets. Pliny is supposed to have referred to this glass when he wrote, "*Album et murrhina aut hyacinthos sapphirosque imitatum et omnibus aliis coloribus*," in describing the transparent and opaque colored glass which was so highly valued in his time.

Perforated silver glass-lined cups.

In this series there were silver goblets, or cups, with elliptical perforations half an inch long at the sides, through which an inner lining of sapphire or ruby glass protrudes like gems. The whole surface seems set with round cut and polished sapphires or rubies. The glass lining of the silver is perfect throughout, but bulges and protrudes through the openings. It is evident that the silver goblet is first made and polished, with the openings left in the sides, and then, being warmed, is lined with glass by blowing a bulb inside of it, the lining protruding through the spaces. These linings were, of course, very tight and close fitting, and could not be removed without breaking or melting the silver. These cups are copied from an original in the British Museum. Sapphires, emeralds, amethysts, and rubies were thus imitated.

Onyx cup.

Castellani.

A cup in imitation of onyx—a copy of one in the treasury of St. Mark's—was mounted in silver gilt by Signor Castellani; another, also copied from one in St. Mark's treasury, and mounted in silver by Castellani, has the colors of topaz and emerald. A *patera* in murrhine colors, white, blue, and yellow, is a fac-simile of the original in the National Museum at Naples.

Some vases, in imitation of agate, are copied as to form from originals in Signor Castellani's collection.

Cameo glass.

Cameo glass.

There were interesting specimens of glass prepared for cutting like cameos. Cups and bowls for this purpose are formed of an inner body or layer of dark blue glass, with an outer coating or layer of even thickness of opaque white

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ITALY.

glass, in which the design is wrought by carving or grinding down to the dark-colored sub-layer, or foundation. This outer white layer is about one-eighth of an inch thick, and is chiseled in high relief, in a similar manner to that by which the Portland Vase in the British Museum was formed, and also the Pompeiian Vase in the museum at Naples. It is a difficult task to get glass mixtures that have exactly the same degree of shrinkage on cooling. The two differently colored pastes must shrink exactly alike, or cracking would result, especially when the outer layer is chiseled away in forming the design.

Cameo glass.

Christian and other grafito glass.

Grafito glass.

The specimens Nos. 74 to 79 are chiefly *paterœ*, cups and dishes decorated with colors and engraved or etched films of gold leaf. Several *paterœ* of early Christian style are reproductions from famous examples preserved in the Christian Museum of the Vatican, and are ornamented with medallions in etched gold leaf, inclosed between two layers of glass. A dish is ornamented with subjects on etched gold leaf representing the Bible history from chaos to the crucifixion of St. Peter; diameter sixteen inches. Many of these objects may be considered as restorations, being modeled from mere fragments, which, however, served to indicate the full and complete form of the ancient vessel.

Vatican museum.

Mural glass mosaics.

Glass mosaics.

This company has executed a great number of important decorative mural mosaics in Great Britain and on the Continent. The perfecting of this art, so extensively practiced in the middle ages, has engaged the earnest attention of the company. It was not until numerous costly experiments had been made that they successfully reproduced the ancient smalti tints, examples of which were shown. Among the mosaics shown, one was particularly interesting as a precise reproduction of one of the spandrils designed by and executed under the direction of Raphael in the ceiling of the Chigi Chapel in the Church of Santa Maria del Popolo at Rome, representing one of the signs of the zodiac, with two figures. Another piece, a panel, represents at the upper end the conversion of St. Paul, and is on an Arabic-Byzantine ornamentation. This and thirteen other similar panels were executed by the Venice and Murano Company for the Gibbs's Memorial in Tyntesfield Chapel, near Bristol, England.

Ancient smalti tints.

Copies of Roman mural mosaics.

Gibbs memorial.

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Reference to Charles Colné's report, following.

For full details regarding the various exhibits in Class 19, I refer to the following report of Mr. Charles Colné, who has long been practically familiar with the manufacture of glass, and has presented a very interesting view of the subject of the display at Paris, and the practical lessons taught by examination of the European methods and results.

WILLIAM P. BLAKE,
Honorary Commissioner.

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GLASS AND GLASS WARE.

Short and imperfect notices of glass in previous reports.

In the reports of the American Commission upon the Paris Exposition of 1867 very little is said upon the subject of glass. A few short notices are to be found on the Siemens furnaces, light-house lenses, Feil's glass for optical purposes, the plate-glass exhibits, and stained and painted glass, but nothing is said on the *technique* of glass-making.

United States Commissioners' Report on Exposition at Paris, 1867.

United States Commissioners' Report on Exposition at Vienna, 1873.

The reports of the American Commission upon the Vienna Exposition, 1873, contain simply a notice upon the machinery and the application of Tilghman's sand-blast process, upon cryolite used in glass-making, and a short allusion to chemical glass-ware. It is a little singular that an exhibition held in the center of so important a glass-producing country should have received no notice of its glass industry by the United States Commissioners.

French Reports on Exposition at Vienna, 1873.

The French report on glass at the Vienna Exposition contains about thirty pages, several of them devoted to statistics upon the extent of the Bohemian glass manufactures; upon the Italian fancy glasses and mosaics; upon plate and window glass, bottles, optical glass, enamels, and pearls; and closing with a notice on the sand-blast process.

United States Centennial Exhibition Report.

The report on our own Centennial Exhibition is scarcely more than a catalogue of exhibitors, and contains no statistical or descriptive information.

English Report on Centennial Exhibition.

The English Centennial report, beside a short dissertation upon the glass of different countries, a flattering notice of our own manufactures, a short historical sketch of them, and a very brief review of the exhibits, contained nothing whatever descriptive of the glass business.

French Report on Centennial Exhibition.

In the French report on the Centennial is a short notice of about four pages, simply noticing our pressed ware and a few things which are novelties to French manufacturers.

In these reports ceramics and glass have the same reporters. These arts are closely allied, but much more interesting descriptions are given in the ceramic department.

In the information furnished by our home manufacturers I received lists of prices which would have been interesting at the time they were given. Business, however, having shown great activity, and the demand for

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goods having increased, these prices are no longer useful, as a great rise has taken place of late. It is not necessary to include in these reports the statistics of imports and exports in glass ware, as our government publishes regularly, through the Bureau of Statistics at Washington, all information desired on that subject.

Countries which made a display of glass at Paris, 1878.

The display of glass at the Exposition was principally confined to the French, British, Austrian, Italian, and Belgian sections. A few scattered exhibits were found in Spain, Portugal, Russia, Norway, Sweden, Hungary, and Holland, but nothing worthy of special mention. Germany did not exhibit.

Scant exhibit of United States products.

Meriden Glass Company.

The United States, as we have already mentioned, had but a very scant exhibit—a few cut flint-glass articles from the Meriden Glass Company of Connecticut. It is much to be regretted that more of our works did not exhibit some of their celebrated pressed wares. Feeling that America should not remain unrepresented at a world's fair, the writer of this report had some glass-ware sent to him and exhibited, but unfortunately too late to receive any premium, which it certainly would have received. These goods were exhibited in the United States annex. Although, through delays and slowness of management of the French line of steamers, these goods were only on exhibition about a month, they

American pressed glass.

nevertheless attracted a great deal of attention from the European manufacturers. Many were the inquiries to know how such thin and large pieces could be pressed without mold marks and with such clearness of metal. These samples were furnished by the Central Glass Company of

Central Glass Company of Wheeling.

Wheeling, W. Va., a company which well deserves the praise bestowed on it in the French report of our Centennial Exhibition. Nothing was found to equal or even approach this American pressed ware in any of the other departments. The beauty and brilliancy of the metal, lime glass, excited the admiration of the foreign manufacturers.

Leading glass countries of Europe.

France, England, Austria, Bohemia, and Belgium may be said to be the leaders in the glass manufacture of Europe. In articles of art and luxury they are vastly ahead of the other nations, as well as of this country. The artistic taste

French artistic taste.

of France is shown in her glass ware, as in everything that is manufactured in that country. The elegance of the shapes, the lightness of the pieces, and the beauty of the glass combine to make her wares remarkably beautiful.

Graceful Austrian wares.

Austria next, by her graceful wares and pretty decorations, variety of shapes, and beautiful engraving, may be

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said to be unsurpassed, and ranks with France, though she leans more towards the old Germanic art. Austria.

England, with her splendid execution of workmanship, her regularity of work, her beautiful engraving, equal in many respects to the Austrian, her splendid and brilliant flint, the purest to be seen, maintains a position in the glass industry of which she is justly proud. English superiority of workmanship and quality of flint glass.

Italy, with her profuse imitation of ancient glass ware, vases of irregular shapes, flasks with flattened sides, awkwardly designed wares in all varieties of colors, more or less perfect, her looking glasses overloaded with a mass of multicolored glass-leaves, her chandeliers containing all the colors imaginable, is not calculated to impress any one with the idea that her work is well executed and harmonious in colors, taste, or design. Italian reproduction of the antique. Overloads of ornament.

Belgium did not represent what she is capable of doing—the largest manufacturers of table ware, etc., not having deemed it worth their while to exhibit. Judging, however, from what I saw five years ago in the dépôt of the principal manufactory of Belgium, the Val St. Lambert, the glass industry in that country, if not fully up to other countries in high artistic productions, is, in the more strictly useful line, at least capable of competing successfully with other nations. Belgian exhibits confined to window and plate glass.

It has been the aim in this report to give to our manufacturers whatever information I could procure, which I thought might be useful to them.

I acknowledge with pleasure the valuable help received from several persons with whom I corresponded. In Austria, Mr. L. Lobmeyr, the celebrated glass manufacturer of Vienna, very kindly gave me valuable information about the Austro-Hungarian glass industry. His work, "*Die Glasindustrie: ihre Geschichte, gegenwartige Entwicklung und Statistik*" (the Glass Industry: its History, Present Improvements, and Statistics), is spoken of very highly by competent authority. To Mr. J. M. O'Fallon, the talented artist and designer of Messrs. Thos. Webb & Sons, of Stourbridge, England, I am also indebted for valuable information upon the glass interest of England. The almost total absence of published information in England upon her glass works makes it a difficult matter to collect data upon the subject. Acknowledgments of assistance: L. Lobmeyr. J. M. O'Fallon.

Thanks for information furnished are also due to M. A. Lacroix, of Paris, the celebrated manufacturer of colors for painting on china and glass. A. Lacroix.

Messrs. Adams & Co., of Pittsburgh, the well-known glass manufacturers, furnished me such complete informa- Adams & Co.

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Acknowledgments of assistance:

tion about the glass industry in this country that I found it a material help.

Day & Williams.

Messrs. Day & Williams, window-glass manufacturers, of Kent, Ohio, furnished very valuable information on that branch of glass making. I desire also to acknowledge

Thomas Gaffield.

valuable help from Mr. Thomas Gaffield, of Boston, an ex-manufacturer, now an amateur and lover of the glass art. His experiments on the discoloration of glass have been eulogized by nearly all competent writers on glass, and his services as an investigator are well known. I have received several publications from their authors and publishers, and wish to express my thanks for their kindness. They are as follows:

Publications on "Glass" received.

"Pottery," by Geo. Ward Nichols, Cincinnati.

"China Painting," by Miss McLaughlin, Cincinnati.

"Hints to China and Tile Decorators," by John C. L. Sparkes, Boston.

"*Faïence*," by Madame L. H. Brasier de la Vauguyon, Boston.

"China Painting," and a very fine album, by Camille Piton, principal of National Art Training School, Philadelphia.

"Report of the Belgium Commission on the late Paris Exposition," from M. Jules Deprez, manager of the Val St. Lambert Glass Works, Belgium.

Paul Dejardin.

I am also indebted to M. Paul Dejardin, of the French legation, for valuable books.

Improvements anticipated at the period of the Exhibition of 1883.

I hope to see in our next exhibition, which is now projected, vast improvements in our glass industry, especially in the fine wares which are seen in such abundance abroad, and which are so rarely met here as the production of our home works, and hope that we may soon emancipate ourselves from the importation of plate-glass, and that our home capitalists will see the wide field which is opened for such an industry in this country. The importation of table

Our decreased imports of glassware.

and other household wares is fast losing its market here and has almost ceased. With the exception of fine wares and part of our window and plate-glass, we are now supplying our home consumption. Nature has favored us beyond example in laying at our doors, in almost every section

Our abundance of all materials.

of the country, an abundance of materials for glass making. Capital and skill is all that is wanting to make us the first glass-producing nation of the earth. If we act wisely, in course of time we shall command many markets now supplied by manufacturers abroad.

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It is very natural for a nation holding an exhibition on her own territory to make a full display of her industry. It is not therefore surprising that the glass interest of France was fully and well represented. Among the most attractive displays stood the Baccarat exhibit, one of the oldest, and the largest glass manufactory of France. Next in importance are the Clichy glass works, those of Pantin, Sèvres, St. Ouen, and Aubervilliers, all near Paris, and the combined establishments of Vallérysthal and Portieux, in the Vosges.

The principal displays.

To describe minutely the beautiful wares exhibited by these and other factories would require too much space. I cannot be expected to give more than a summary of the principal and most attractive articles.

COMPAGNIE DES CRISTALLERIES DE BACCARAT.

This firm had the largest display, occupied a very prominent position in the glass section, and on account of its well-known reputation was the center of attraction. The prominent object was the glass temple of massive cut glass, on the top of which stood a silver statue representing Mercury. This temple was constructed with an open cupola of flying spandrels, each a solid curved beam, supported by six handsome Corinthian columns—the mythological god in a flying attitude. The base showed a balustrade, upon which, at regular intervals, were placed six vases or urns. The whole temple was made entirely of glass pieces, cut and adjusted to form the structure. The effect was grand and beautiful. Although the *tout ensemble* seemed to be a wonderful piece of design, yet when the workmanship was looked at critically it was easy to perceive that the cutting of the several pieces was far from being regular. Some of the joints were not as close as could be desired, nor were the several pieces cut alike. These defects, however, passed unperceived to the ordinary eye, and the effect of such a dazzling mass of flint glass was really grand. It might be called a *tour de force*, and but few factories are capable of producing such a handsome and costly edifice. In regard to the color of the glass of this firm, although it shows a vast improvement upon that of 1867, as can be seen by comparing the present exhibit with two large urns or vases which were also exhibited, and had already been shown in

Baccarat glass-works.

Glass temple.

As to the limpidity and brilliancy of their white glass.

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FRANCE.

Baccarat glass-works.

1867, yet it is still lacking in the brilliancy and dazzling reflection of light of the English flint-glass.

Chandeliers:

Next to this temple was a very large chandelier, with a solid glass bottom bowl cut in prisms; the drops made of cut green upon ruby doubled glass, the *bobêches* or sockets cut on the border and painted in enamel colors. Another chandelier, equally large, was entirely of flint glass, the bottom being formed by a large ball cut in diamonds, some of the drops bell-shaped and others cut in prisms, with a sharp point. Quite a number of other chandeliers were also shown, some in colored and white flint; among others, an immense one, with crown top. None of these chandeliers, although very handsome, could compare with the matchless productions of the Oslers, in the British section, in boldness of execution, design, or perfection of work. The following articles are also worthy of mention:

Compared with Osler's.

Notices of articles exhibited.

A very handsome toilet box, representing a temple with glass columns, mounted in silver, the panels and top beautifully engraved with the wheel.

Several urns of amber and white glass, acid-etched. These urns or amphoræ, with an etched head, were mounted upon tripods of cut glass, with rings hanging from the top of the branches; a very handsome design.

A game of chess, with board and men of glass, the board mounted in gilt metal; the chessmen depolished, one set in white glass and the other in ruby; the squares upon the board had been etched, representing alternate white and ruby squares.

A large variety of quaint-shaped and oval articles engraved in clear and dead surface. The thin wares of this house, although very handsome, do not equal others exhibited elsewhere.

A number of blocks of glass cut in diamond, showing the purity of the glass.

A white glass set, cut in olive pattern, with splits in the middle, cut spirally around the articles; a very handsome pattern of cutting.

Very large and heavy oval dishes cut in deep diamonds.

A light *mousseline* set, with wheel-engraving.

Another set cut in narrow flutings interspersed with diamonds. A very pretty combination, but the flutes were not cut very regularly.

A thin blown set engraved with an armorial device representing a horse and a deer, in dead surface; finely done.

A number of articles having very thin and long handles made of two rods of glass twisted together. Many of them, however, were put on crooked.

A large number of vases in opal, decorated in the Bohemian style, were well done.

A pair of dishes with twisted handles in deep copper ruby of a very good quality.

Flagons engraved with horse's heads, handsome borders, and hollow blown handles.

Ruby vases, etched.

A jewel box in gilt panels, engraved, with dead surface.

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Amber and ruby vases, engraved and etched, with four twisted and knotted handles; well executed, but not put on as correctly as the English.

Several articles blown in ribbed or indented molds, free from the creases generally seen in the bottom of the ribs.

A few pieces of thin muslin glass decorated in enamels, in very good taste.

Coffee-pots and salvers in the same style of decoration on white and ruby glass.

Square vases of black glass, with Japanese decorations in very good style; the black glass of especially fine color.

Two very large and heavy glass vases or urns made up of a number of solid pieces of glass cut in bamboo. These vases had already been exhibited in 1867. The glass was in striking contrast with the present quality, being of a gray bluish cast, which kills all the brilliancy of the material. Baccarat glass-works.

Four very handsome Grecian solid cut-glass vases in bamboo pattern, with short handles, a spiral cord cut on the body of the vases. Very handsome and striking articles, said to be worth $660 each.

Two large toilet tables of flint glass with tripod feet, the tops cut in small diamonds running spirally, the stem of the same pattern, the feet cut in heavy leaves and projecting knobs. These tables are some of the best specimens of cutting of this house.

A large number of candelabra cut entirely in diamonds, branches, drops, etc. Notices of articles exhibited.

A lot of small chandeliers with a ball center-piece painted in enamel.

Etagères and fruit bowls in a great variety of patterns.

A blown elephant, depolished in acid, and carrying at the sides small glasses; used as a liquor stand.

A flower stand with a heavy cut fluted bowl mounted in gold, others in silver, the base or foot cut in diamonds.

A set of table ware cut in heavy splits and diamonds, with heavy cut bamboo handles.

Two large hexagon opal lamps, decorated in Japanese style, in gold and colors.

A large variety of articles blown in semi-muslin glass, engraved in depolish, clear and half clear, of various designs.

A variety of small liquor-stand bottles, with twisted stoppers.

Large vases of ruby upon white, in deep depolished engraving, handsomely executed.

A coffee-pot, amber upon white, with salver etched in depolish.

Vases and jewel boxes in a peculiar bluish opal which was not seen elsewhere.

A large solid ball of glass to show the quality of the metal. An excellent glass, free from impurities, *stria*, or air bubbles, and very fine in color.

A few pieces of flint glass, with spun-glass threads of different colors; all well done.

A jug with four compartments forming the body.

A number of statuettes, depolished in acid.

A very large punch bowl, with large waiter, glasses, and spoons, all cut in handsome diamonds. This punch bowl is one of the largest pieces on exhibition.

Two handsome flat flagons, decorated in enamel colors, representing a peacock and a snake, both exquisite in design.

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FRANCE.

Baccarat glass-works.

Acid-etching.

Enameled decorated ware.

Colored glass.

Engraved glass.

Opal glass.

I have only described the different styles of goods and decorations, as it is impossible to convey an idea of the styles and designs of wares without illustrations. Much of the acid-etching of this house, although done by the printing process on paper and transferred upon the glass, is of a remarkably fine finish. This is accounted for by the fact that many of the imperfections are corrected by scratching the designs with a needle by skilled workmen. Their enameled decorated ware is in imitation of the Persian style, and is very well done. The colors of their colored glass are very pure and brilliant; I noticed particularly their amber and ruby. The engraving, although well executed, is not in any way superior, and in many cases is not equal to the English or Austrian. The decorations upon the opal glass vases and the thin blown wares of this firm are very handsome. In a word, the late Exposition showed us that the well-deserved reputation of this house is as good as ever, but it cannot be denied that some of the glass works around Paris are producing goods fully equal, and sometimes superior. For instance, the thin blown muslin glass wares of Clichy cannot be surpassed.

The Baccarat glass is well known in this country, and is often to be seen on the shelves of our dealers. Some of our manufacturers recognize the fact that the goods of this house are models of taste, and we find their shapes reproduced in pressed glass with very good success.

Clichy glass-works.

"CRISTALLERIE DE CLICHY," near Paris.

This is the next firm in importance, and is noted for the beauty of its wares. The variety of goods of this house is almost as great as that of Baccarat. Among the noticeable articles are the following:

Notices of articles exhibited.

Two large urns, ruby upon opal, the ruby plain, of a dark hue, but very brilliant. This combination makes a very handsome shade of color.

A large bowl, of twisted filigree laid horizontally, and kept very straight in blowing, the bowl very thin, mounted on a gilt stand.

A pair of crystal bowls, with spiral bamboos, cut and scalloped border.

A water set, rose upon white, cut in diamonds. This bowl shows the peculiar defect inherent to almost all doubled glass, viz: the irregularity of thickness of the upper coat of glass. In looking at the stem, which was cut in flutes, the irregularity was quite perceptible. The waiter of this set was square, and also cut in diamond, with a scalloped border.

Handsome vases of black glass, decorated in enamels of different colors and in dead gold; very handsome.

A large oval bowl with solid ball foot, scalloped border, cut in heavy diamonds.

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Another of the same shape, opal inside, and rice-colored glass outside. The combination of these two opal colors gives a peculiar shade to the article which is very pleasant.

Jugs of depolished glass, with a hole in the middle of the body, and a spirally twisted snake handle.

Venetian bowls, with twisted stems, blown very thin, with deep, bulging pockets on the border. These are made by blowing in molds having recesses. In heating the article the pockets deepen and throw the border into scallops.

Two lamps of dark ruby, lined with dark or black glass; the body crackled, and the inside lining showing through the cracks. This is accomplished by reheating the two layers and shaping. By repeated reheatings the colors are metallized.

Very thin blown sets, cut in very small line diamonds; a handsome and difficult piece of work.

Two large, heavy crystal baskets, with solid handles and sides pressed in; well blown.

Vases of opal, ruby, and white glass, with gold metallic flakes.

A couple of covered dishes in ruby, engraved in the Bohemian style; ruby coat put on by painting the outside.

Clichy glass-works.

A lamp of ruby on opal, showing a very pretty and soft rose color by the combination of these two shades.

Several jugs of white and ruby crackled glass, with spiral snake handles around the body; handsomely made.

Thin bowls in white crystal, with opal filigree; the stems made of four filigree tubes laid parallel; a fine piece of work.

Notices of articles exhibited.

Vases of opal upon white, mounted in gilt frames; vases painted in white enamel, Japanese style; vases in greenish glass, mounted in gilt metal and painted in clear and dead gold, representing dragons, in the Japanese style.

Sets of very thin crystal, with handles and stoppers blown hollow, engraved in light patterns and filled with dead gold; a strikingly handsome effect.

Lamps in ecroid green upon opaque glass, mounted in bronze.

Two very handsome light-rose-colored jugs, with white crystal foot, mouth scalloped, hollow handle, engraved in depolish.

Toilet flat boxes in colored glass, with white glass powder spread over; not a happy combination.

Two large ruby cornucopias mounted on a ruby square base; border of cornucopia scalloped; the whole mounted in gilt metal.

A set of thin muslin-crystal glass, with engraved monogram, filled with dead gold.

A set of the same style in green glass; both very handsome styles.

A large casket in deep ecroid green upon white, cut in diamonds, mounting in bronze; a handsome article.

Very large opal vases, plain and decorated, mounted in gilt frames.

Lamps of different colors, mounted in gilt metal, with tulip-shaped globes, engraved, etched, and cut.

Bottles, vases, and bowls of spiral filigree in Venetian style; very handsomely done, and much more regular than the Italian wares. The opal, black, ruby, and all other colors of this firm are very fine.

Peculiar spirally ribbed crystal articles, with opal spiral ribs. These seem to have been made with alternating ribs of white and opal filigree, upon which glass has been blown and the article subsequently shaped.

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Clichy glassware.

Clémendot.

This firm exhibited a number of small articles made of a glass covered with a coating of pearl-colored substance, which is said to have been discovered by M. Clémendot, the celebrated chemist, who is an authority on glass in Europe. It is probably an oxidation on the outside surface of the glass, and seems to have been produced by an acid. I do not see anything very promising in this, however, as the color is lusterless and very uneven in shade. It is not even a good imitation of the false pearls which are so well made in Paris.

Pearly coated glass.

Muslin glass.

The thin blown muslin wares of this house are remarkable in regard to their extreme thinness and regularity of workmanship. Their hollow handles, stems, and stoppers are also wonderfully well made. The white flint and colored glass are of excellent quality. The ability displayed by their workmen is striking, and all the goods of this house will stand favorably in comparison with those of other manufacturers more famed.

Messrs. Maës Brothers are the proprietors of these works.

Pantin glassworks.

CRISTALLERIE DE PANTIN, near Paris.

Monot Père et Fils et Stumpf.

These works made a very handsome show of white and colored glass, equal to any in many respects. The principal articles I noticed were as follows:

Notices of articles exhibited.

A large, handsome, and solid table of crystal, the top cut in rectangular diamond, and the border cut in a raised scallop, the leg and foot also cut in diamonds. The different pieces making this table are fitted into one another by means of recesses and sockets; the work is so beautifully done, the metal of such purity, that the joints cannot be detected. This is one of the most regular and handsome pieces of work in the Exposition, superior to the tables shown in the Baccarat exhibit. This table was sold to the Shah of Persia for $1,500.

A number of vases engraved in heavy relief, well executed.

A large crystal dish, decorated in enamel colors, finely done; but this style of decoration is more suitable to porcelain than to glass.

Vases in ruby glass, engraved, but inferior in color and work.

A large lot of crackled ware, showing two and three colors; some showing only two colors up to a certain point and three colors above; some show deep cracks and others a smooth, uniform surface.

Vases with yellow metallic flakes, (in the style of the Aurora Glass Company, of the British section), of different colored glass; some crackled, some plain.

A large variety of aventurine goods, very beautiful. This house is celebrated for the beauty of its aventurine glass.

A few decorated articles in the Persian style, with enamel colors.

Articles in opal filigree, well done.

Paper weights of solid glass, containing glass snakes, lizards, squirrels, and flowers; air-bubbles are distributed in the mass, looking like pearl-drops.

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A large lump of aventurine glass, showing how irregularly the yellow spots are distributed.

A coiled snake, with head erect, of two colored glasses, cut in spots to show both colors, mounted upon a piece of mirror; an interesting piece of workmanship, showing great dexterity in coiling the snake.

Two large candelabras, urn-shaped, cut in bamboo, heavy diamonds, and leaves, glass branches and drops bell-shaped; a very fine piece of work, said to be worth $5,000 the pair.

Articles with hollow handles and others with three twisted branches.

A peculiar glass to be found in this house, and said to have been invented by M. Monot, one of the proprietors, is a shell blown of black glass, having a copper-colored inside-lining thin enough to be transparent. This is presumed to be a metallic oxidation taking place while the article is blown. Several fancy articles made of different colored glasses were lined with this metallic coating, and looked very pretty.

Very large crystal bowls cut in octagonal diamonds and fillets across the face; scalloped borders.

A dark ruby dish in very fine color.

Large oval and round bowls, cut in elegant designs, representing flowers in imitation of high-relief clear engraving.

Pantin glass-works.

Jewel boxes in colored glass made of two round shells, mounted in gilt metal and decorated in enamel.

Decanters and goblets completely cut all over the surface in bamboo.

Thin muslin goblets, with engraved clear border, in the style of engine-lathe engraving on metal.

Notices of articles exhibited.

Paper weights in millefiori of roses, leaves, and fruit, embedded in lumps of clear glass.

A very fine deep ecroid green bowl, cut in flutes, cross-cut with fine fillets, and decorated over in clear gold.

Several muslin bowls with colored cut and twisted serpent stems.

A rose-colored vase with yellow metallic flakes in the mass; a fine contrast.

Thin blown crystal goblets and decanters, decorated and gilt in the Persian style.

A handsome water set in very light rose color, engraved and cut.

Two deep-blue vases, engraved and cut.

A number of vases in the Bohemian style, decorated in enamel and gold; well done.

Clear amber articles, with light designs in white enamel; the effect is very pretty.

Articles of crystal with amber outside, cut and engraved; also very handsome.

Liquor caskets mounted in gilt frames, with bottles and glasses cut in diamond, the frame forming a canopy.

Set of muslin glass goblets with cut stems and monograms; very finely blown.

Light rose-colored articles engraved in depolish and clear; a beautiful color.

A jug and tall goblet of amber upon white, showing parts cut and engraved, the amber color covering the pieces all over, even the cut and engraved parts; a fine specimen of what can be done in the way of decoration, even after the article has been cut.

Vases of handsome black glass decorated in enamel.

A paper weight, containing a lizard of colored glass, which had been cut in several parts before being inclosed in the glass.

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Pantin glass-works.

The engraving of this house cannot be compared with that of the English and Austrian sections. To remedy the defects shown in colored glass of two colors superposed when cut, it would be advisable to select designs which leave the cut parts in relief, thereby avoiding the unpleasant effect of irregular lines caused by the unevenness of the layers of glass. In the works of this house, as of most others, I noticed many irregularities in the cutting of fluted articles, the lines being crooked and the width of the flutes uneven.

I do not think that patterns cut or engraved in clear relief are pretty; the designs are confused by the reflection of light, and to appreciate this work one must get close to the articles in order to distinguish the outlines of the patterns. The diamond cutting of this house is excellent, and the glass of a very good quality.

Lissaute & Cosson's glass-works.

LISSAUTE & COSSON'S GLASS WORKS at Aubervilliers, near Paris.

This firm also made a fine exhibit. The principal noticeable articles were:

Articles exhibited.

A large number and variety of their seltzer-water bottles of white and colored glass—blue, ecroid, amber, ruby, and other colors—cut, engraved, and gilt. The colors are all very good, especially the amber.

Large black glass vases decorated in gold, Japanese style.

Lamps with incrustations of colored and pearl ornaments on black glass, Japanese figures and pearl-colored flowers in relief.

Large gas-reflectors of colored glass, decorated and plain.

Opal globes and reflectors molded in convex ribs.

Vases in light-blue glass, painted in black, so as to show the blue through; a very pretty effect.

Two very large urns—one blue, the other rose-colored—4½ feet high, made of three pieces.

Large globes in opal and white glass, etched in depolish, 2½ feet high; also a large etched globe, egg-shaped, 2 feet high.

A couple of vases in white crystal, decorated in white enamel; not a very successful attempt.

Colored glass, and large vases.

The colored glass of this house is very good, especially the black. This house had the largest vases and globes in the French section.

Wallérysthal & Portieux glass-works.

SOCIÉTÉ ANONYME DES VERRERIES RÉUNIES DE WALLÉRYSTHAL ET PORTIEUX, at Wallerysthal (Alsace-Lorraine) and Portieux (Vosges).

Half-flint glass.

This establishment manufactures half-flint glass, and is one of the few establishments exhibiting pressed glass. The striking articles are a variety of candlesticks in different colored glass; blue amber, ecroid, etc. This pressed ware is inferior to our own, but is some of the best shown in the French section.

Articles exhibited.

A large exhibit of goblets, decanters, tumblers, etc., cut in short flutes, such as are used in all the restaurants of Paris.

Plain blown articles, with light engravings.

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Two large vases, with bronze feet decorated on a background imitating bronze, with fillets in dead and clear gold.

Opal vases mounted in gilt metal and decorated; a good contrast.

Wallérysthal & Portieux glass-works.

Large vase with metal gilt mounting and handles, also a gilt-metal border at the base, decorated with birds and nests in relief, looking like tarnished tin ornaments, cemented or melted upon the surface of the glass.

Articles exhibited.

A set of vases with covers decorated in dead silver.

Large candelabra of cut glass, with flat drops cut on the angles.

Opal vases decorated with gilt-metal mounting.

Large black glass vases decorated in raised enamel colors.

A variety of pressed ordinary articles in amber.

A molded set showing convex ribs and deep splits across the ribs.

Pressed glass match-stands in black glass, with raised patterns, upon which opal beads are put on; some beads in dead gold and others in white enamel; the white makes the best contrast.

Inferior color of the glass, and quality of the pressed ware.

The color of the glass of this house is inferior and has a low brownish reflection, which is unsightly. The pressed ware is much below the standard of American glass; the mold-marks are quite perceptible, and the goods have the peculiar greasy and wavy surface of pressed ware. The proprietors of these works were very much pleased with the American pressed ware the writer had on exhibition in the American section. Were it not for the difficulties created by the French tariff, American pressed glass could be exported to France with advantage.

The plant.

This firm, as I mentioned, has two glass works. Those of Vallérysthal have two Siemens furnaces, with 12 pots each, a Boëtius furnace with 10 pots and another Boëtius furnace with 6 pots. These works employ 920 workmen. The Portieux Works have three Siemens furnaces, of 12 pots each, and 715 workmen. All these furnaces use coal. Fifty-two thousand eight hundred pounds of glass are melted every day. Colored and white glass is manufactured into table and other hollow wares, pressed in all patterns. The cutting-shop machinery is put in motion by hydraulic motors and by steam. The buildings are usually one story high, with glass roofs. Five hundred and twenty workmen are employed in these shops.

Products.

Cutting machinery.

Workmen.

Engraving.

Sand-blast.

The engraving is done with the wheel and hydro-fluoric acid. The firm is about putting up a sand-blast apparatus. The decorations are made by the printing process or by hand, and are fired in a muffle.

American molding-press.

This firm has ordered a press and a set of molds from a Pittsburgh maker, thereby recognizing the superiority of American pressed glass (*vide infra*).

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CRISTALLERIE DE SÈVRES, A. LANDIER & HOUDAILLE.

Sèvres glass-works.

This factory is also situated a short distance from Paris, and is one of the houses which, like those previously mentioned, has much to be commended in its exhibits. The principal articles worthy of notice were:

Articles exhibited.

A number of very thin blown decanters, sugar bowls, goblets, etc., with hollow handles and stoppers.

A large vase of opal and green glass, crackled, the opal spots predominating and the green showing only in small spots.

A basket of opal and green, showing squares of green glass between opal fillets; very handsome.

A large variety of finely cut table services.

A very fine vase of opal, ruby, and white glass, cut, showing opal squares, ruby fillets, and clear glass squares, the foot cut showing the ruby and clear glass and the fillets in opal.

Vases executed in the same style in clear opal and green spiral diamonds. This effect is evidently produced by cutting away certain layers and leaving the others—a style of cutting which can readily be done with very thin coatings of colored glass, leaving the article with an apparently even surface, owing to the thinness of the coatings.

A very large oval bowl in crystal and deep blue, beautifully cut in diamonds.

Solid baskets of crystal in one piece, with the handle cut out.

Blue and gilt vases.

A very large crystal candelabrum, with six branches very heavily cut in diamonds and bamboos, handsomely cut drops; one of the largest pieces of the Exposition.

A variety of richly cut glass ware, some with heavy knob borders and others with very deep splits and diamonds.

A large piece of green aventurine glass, made with sesquioxide of chrome. This aventurine is harder than the Venetian; the distribution of the green spots, however, is as irregular as in the yellow aventurine. I do not think that this green aventurine will ever be used to any great extent, as the contrast between the body of the glass and the green crystals is but slight. Several pieces made of this glass were exhibited, but none looked well.

Heavy oval bowl in ruby upon white crystal, handsomely cut in heavy diamonds.

A variety of filigree and other Venetian wares; finely executed.

Vases with heavy relief clear engraving and cutting.

Articles with half-clear engraving.

Vases of dark ruby upon opal, with handles of ruby upon white and base of the same; a happy combination.

Vase of crystal, opal, and light ruby superposed.

A vase of light ruby upon crystal, engraved very deep and clear.

A large variety of decorated wares.

Quality.

The quality of the flint glass of this house is very good, with the exception of a slight tinge of gray. The colored glass is very pure.

Pannier-Lahoche & Co.

PANNIER-LAHOCHE & CO., Paris.

Two very large decorated vases, mounted in gilt metal, for candelabra, with branches in metal, foot cut with clear and depolished deep engraving; price, $1,000 a pair.

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A very long trumpet glass, 7½ feet high, engraved in clear flowers.
A large variety of white and colored goods, engraved in relief.
Decanters, blown with inside bamboos.
Jugs, with tears of white and blue glass over the face—a very ugly pattern, in imitation of Arabian glass.
Vases with handles attached to each side and bent over together.
Decorations in raised enamels on different kinds of wares.
A vase, ruby upon white, engraved in depolish; very handsome.
A flower vase of two joined trumpets, with painted bodies; worth $140 a pair.
Vases decorated with metallic ornaments in relief, in the antique style.
A few pieces of Venetian glass ware.

Pannier-Lahoche & Co.

DOMONT, SAUVAGEOT, & CO., Paris.

Domont, Sauvageot & Co.

Large prismatic blocks of glass, very free from striæ and bubbles, but low in color.
The usual ordinary glass ware for restaurants.
Blown and cut Venetian articles in white and colored glass.
Three branch-stemmed articles; well executed.
A few decanters decorated with spiral colored threads, put on widely apart.
A decanter of amber upon crystal; the combination makes a very pretty and brilliant light-amber color.
A few articles with English shell handles, but badly put on and very irregular.
Light blown articles with convex ribs, twisted in finishing.
Muslin thin glasses, decorated lamps, etc.

The goods of this house are only ordinary and deserve no special notice.

AUBRIOT-ROUSSAUX, CUCHELET, & CO. Clairey (Vosges).

Aubriot-Roussaux, Cuchelet & Co.

A large number of tumblers, decanters, sugar bowls, flagons, liquor-sets in half-muslin glass, principally cut in flutes.

SCHMID & DU HOUX, Faing (Meuse).

Schmid & Du Houx.

A variety of pressed goods, sugar bowls, saucers, candlesticks, fruit-dishes, and the usual common restaurant wares. The pressing of this house is quite inferior, full of wrinkles and mold-marks, and the glass of inferior quality. The only article worthy of notice was a liquor-stand, with four united compartments, having glass cocks fitted in each.

BOISSIÈRE & FILS, Gast (Orne).

Boissière & Sons.

Chemical and druggist ware. A peculiar patented decanter, blown with an open bottom; the bottom piece is pressed separately, with a projection, around which is placed a rubber ring; this bottom piece is forced into the decanter, and by its pressure against the sides makes a water-tight joint. Also a four-compartment decanter, with separate stoppers, a large glass still, and candy jars.

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VEUVE E. A. GUERNER, Croismare (Meurthe-et-Moselle.)

E. A. Guerner. Plain vases in colors, some ruby on crystal, green on crystal; dark blue vases painted and ornamented; cut and pressed table ware. Most of the goods of an inferior quality.

Meyer Sons & Brothers. *MEYER FILS, FRÈRES. Donzy (Nièvre).*

Perfumery bottles, druggist and chemical ware, preserve jars and glasses, flasks, etc. Nothing remarkable except a peculiar means of stopping bottles by the use of an inverted cup-shaped top, which is made to cover the stopper. Around the neck of the bottle is placed a rubber ring in a recess; the cup is pushed over the ring and thereby forms a tight joint.

Furnaces. The works of this firm use a furnace of their own invention, burning coal for melting and wood for working. They melt in 11 to 12 hours 9 pots, containing about 800 pounds, with an expenditure of 28 to 30 lbs. of coal. They

Molds. use cast-iron and wooden molds. Each set of workmen is composed of two blowers, a finisher, and a carrier boy; 14 of these sets work on the furnace, say 56 hands, making per day twenty to twenty-five thousand pieces.

Loire & Rhône glass-works. *COMPAGNIE GÉNÉRALE DES VERRERIES DE LA LOIRE ET DU RHÔNE. Rive-de-Gier.*

A lot of pressed ware, principally tumblers, very thick and pressed very badly. A large assortment of plain blown and cut restaurant wares, cut pretty regularly. An immense decanter cut in punties and squares of cross-cut diamonds, the cutting done very finely.

M. A. Coyen. *M. A. COYEN, Paris.*

Bottles stoppered by means of screw-threads pressed upon the neck, fitting a cap having a corresponding screw and containing an elastic washer inside—a well-known system in this country; yet it is heralded by this maker as a great novelty, having required the making of several new tools, which he claims to be patented. The same system of closing is applied to the bottom of bottles, which are screwed to the bottle and made tight by a washer.

C. Le Blanc. *C. LE BLANC, Paris.*

Black glass vases, decorated and gilt; also crystal vases of the same style; ordinary pressed ware of the usual inferior quality; common restaurant tumblers and decanters; a seven-compartment bottle and deceiving doubled-sided goblets.

I regret very much that I have not been able to procure cuts of the beautifully shaped glass ware of France.

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Plate glass.

Plate glass.

The principal plate-glass manufactory of France, the "*Société Anonyme des Manufactures de Glaces et Produits Chimiques de St. Gobain, Chauny, et Cirey,*" owns the works of St. Gobain, Chauny, Cirey, and Montlucon, in France, and Mannheim and Stolberg, in Germany. There are two other factories besides at Jeumont and Aniche.

St. Gobain plate-glass works.

The following plain white and silvered plates were exhibited by these firms:

	Pounds.
St. Gobain: 1 plate 21.15 feet x 13.48 = 285.10 square feet, white, $\frac{7}{16}$ in. thick	1,573
St. Gobain: 1 plate 17.90 feet x 9.94 = 117.92 square feet, silvered, $\frac{7}{16}$ in. thick	770
Jeumont: 1 plate 17.81 feet x 11.51 = 205 square feet, white, $\frac{7}{16}$ in. thick	1,100
Jeumont: 1 plate 17.22 feet x 10.82 = 182.12 square feet, silvered, $\frac{7}{16}$ in. thick	770
Aniche: 1 plate 15.76 feet x 10.43 = 164.38 square feet, white, $\frac{7}{16}$ in. thick	660
Aniche: 1 plate 14.76 feet x 9.05 = 132.58 square feet, silvered, $\frac{7}{16}$ in. thick	550

Mirrors.

The St. Gobain works furnished a number of mirrors to the new Grand Opera of Paris; among others one 21.29 x 9.67 feet; others from 45.12 to 52.48 feet long. In the Exhibition of 1855 these works exhibited a plate 17.61 x 11.02 feet = 194.06 superficial feet. The Cirey works had one of 199.06 superficial feet. In the Exposition of 1867 the St. Gobain works had a plain plate 19.97 x 11.58 feet = 208.90 superficial feet; Cirey one of 21.50 x 10.59 feet = 227.68 superficial feet.

Plate window-glass.

St. Gobain also exhibited $\frac{3}{16}$-inch thick plate-glass for windows, weighing only 22 to 26 pounds per square meter; thick polished slabs, such as were used in the aquarium, 7.56 feet long by 2.60 feet wide, $\frac{9}{16}$, $\frac{11}{16}$, $\frac{14}{16}$ inch thick; a series of silvered reflectors, deck-lights, bull's eyes, plates of a rough cast glass, smooth on one side and corrugated on the other, used for roof covering, weighing about 27 pounds per square meter, from 1 to $\frac{2}{8}$ inches thick. The designs on the surface consist of fine parallel corrugations or small and large corrugated and plain lozenges. The large lozenges are used as a substitute for painted or stained glass in churches for economical reasons. The small lozenges are used for partitions, door-panels, windows, covered yards, hot-houses, roofs, etc.

Reflectors.

Rough cast glass.

Glass tiles.

They also make glass tiles, pressed in imitation of the clay article. These tiles are used for roofing and are molded in

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FRANCE.

Plate glass.

St. Gobain plate-glass works.

Glass tiles.

such a shape that they can be laid alongside of one another, making tight-fitting joints without any cement or mortar; it takes 13 tiles to cover a square meter; each tile weighs about 5½ pounds.

Glass flooring-slabs.

Glass flooring made of flags or slabs of rough cast glass are also manufactured in large quantity by these works; they consist of pieces 6 x 1⅜ inches thick, 11 inches long, and weigh 165 pounds per square meter; the upper surface is generally molded in diamonds. Pavements of glass are also exhibited; these are made in the same style as the slabs, with the upper surface molded in diamonds, but are much thicker, and are intended for pavements for carriage ways. They are made of cubes of about 6 x 6½ inches, and weigh each 19.80 pounds; they are sold by weight. Rough slabs are also made of 6.56 x 2.65 feet, varying in thickness from $\frac{9}{16}$ inch to 1½ inches; weight from 213 pounds to 492.

Light-house glass.

This company also exhibited all the different rough cast glasses used in the manufacture of light-house apparatus, such as rings, parts of rings, and rough lenses. As a specimen of the thickness that can be given to cast glass, there was shown a disk 4.03 feet in diameter by 8⅛ inches thick, weighing more than 1,320 pounds. This disk is an exact duplicate of the one offered to the French Observatory to make a mirror for their large telescope.

Chrome aventurine.

Devitrified and colored glass.

As curiosities this company exhibited some chrome aventurine, devitrified glass and glasses differently colored by metallic oxides. Also a number of beveled pieces of plate glass with holes drilled at both ends for inserting screws. These plates are used for facing doors where the hand usually presses them in opening and shutting, so as to prevent the paint from getting soiled.

Silvering process of Kuhliger-Bouvet.

The silvered plate of Aniche is said to have been silvered by a patented process, by M. Kuhliger-Bouvet, 82 Rue St. Martin, Paris. This firm also exhibited a large number of cylinders for window glass; fluted glass, thin and thick, plain and depolished; ship's deck-lights; door-plates, cut beveled; also roofing tiles made of blown and curved glass, with a turned-up ear for fastening them; these tiles when laid imitate the ceramic tile roofing.

Unsurpassed quality of French plate glass.

As to the quality and perfection of work of the French plate-glass works, it is hardly necessary to say anything, as it is a well-known fact that French plate glass has an unsurpassed and world-wide reputation. The same may be said of their other qualities and styles of glasses.

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Window glass. FRANCE.

Window glass.

The display of window glass in the French section was very full, and represented a state of advanced manufacture equal to any, both in plain and colored glass.

M. A. Pelletier & Sons, St. Just Glass Works.

M. A. PELLETIER ET SES FILS, of the Saint Just Glass Works, had a very full and handsome display, consisting of a number of very large cylinders in plain white and different colored glass, green, yellow, blue, pink, ruby, opal, purple, and greenish blue, all of very fine and pure quality; also large sheets of the same colored glass. A fine assortment of etched sheets of pink and green on white depolished ground. A very fine sheet of amber glass, with dark ruby surface, etched by acid, the amber side depolished—a very fine piece of work, and a happy combination of colors. Specimens of different colored glass with the surface covered over with powdered glass, looking like rough sand paper. This powdered glass had been pressed enough to make it adhere to the surface of the object. A small sheet of opal glass upon white, with certain designs, ground and filled in with gold, the back of the glass being covered with a protecting surface. A large clock dial of opal, very handsome; also handsome shields, engraved and painted. Nearly all the cylinders exhibited in colored glass had a background of white glass. A large dial of black glass, very beautiful. Sheet-glass, white ground, covered with violet, cobalt blue, red, opal, gold, pink, ordinary blue, etc. Also other sheets of opal upon yellow, opal upon green, and opal upon purple, all very pretty. Sheets of dark-amber colored in the mass, very fine.

White and colored cylinders.

Etched sheets.

Powder-surface glass.

Opal sheets.

Clock dials.

Doubled-glass sheets.

Renard, Sons & Co.

RENARD PÈRE ET FILS & CO., of the glass works of Fresnes, exhibited different thicknesses of window glass, running from the thinnest up to very thick plates—some plain and others depolished—blown glass curved tiles for roofing. This firm exhibited very long and very large cylinders. I could not get the sizes, but they were fully equal to those described in the Belgian exhibits. They also exhibited common wine bottles.

Window plates.

Blown curved tiles.

Fogt Bros. & Lemaire.

FOGT FRÈRES ET LEMAIRE, of Aniche, also exhibited very large cylinders, plain and depolished, same as the preceding firm.

d'Hénin-Liétard glass-works.

SOCIÉTÉ ANONYME DES VERRERIES D'HÉNIN-LIÉTARD, of (*Pas-de-Calais*), had on exhibition colored sheet and cylinder glass in blue, bright violet, brown, red-violet, and greenish violet, light and deep yellow, Isly green (a bluish green), corrugated, sheet, and cylinder glass.

Colored cylinder glass.

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FRANCE.

Window glass.

Loire & Rhône glass-works.

COMPAGNIE GÉNÉRALE DES VERRERIES DE LA LOIRE ET DU RHÔNE, at Rive-de-Gier, exhibited a very fine lot of colored window glass in very good colors; also several cylinders of blue, yellow, dark green, and ruby, of very good quality.

Lemaire Brothers.

LEMAIRE FRÈRES, at Aniche, furnished the sheet-glass for the Exposition; they had a good show of plain window glass and corrugated sheets. This firm exhibited a mirror said to have been "silvered" without preparation. The reflecting surface looked very somber, much darker than the mercury amalgam or silver coating.

E. Parmentier & Co.

E. PARMENTIER & Co., at Fresnes, M. DELILLE & Co., at Aniche, were also exhibitors of very good quality of plain and corrugated sheet and cylinder window glass.

Richarme Bros

RICHARME FRÈRES, of Rive-de-Gier, exhibited a lot of large cylinders in plain glass, 7.21 feet high, .94 feet in diameter; another 6.56 feet high, 1.11 feet diameter.

A. Catherine.

A. CATHERINE, of Paris, exhibited a sheet of glass coated with "vitrified stone ware," said to perfectly intercept the rays of the sun, and not to stain with grease. To all appearance it looks like an ordinary depolished sheet.

H. F. M. Baboneau.

BABONEAU, of Paris, had a large assortment of clock shades in white glass, round, oval, and flattened, of very good quality, clear and thin; also colored glass in sheets of blue and other colors, plain and depolished; a very fine plate of black glass, very perfect.

A. N. Miton.

A. N. MITON, Paris, had an exhibit of pin-cushions and artificial flower stands, made of solid glass, cut and engraved, some in plain white and others in flashed colored glass, the whole covered over with square heavy glass covers or shades. The forms were varied, some round and others square. These stands looked very handsome, and are quite ornamental.

Mirrors.

Mirrors.

Fine display.

The display of mirrors, with decorated and ornamented frames made of glass, gilt and black wood, was very extensive and very fine. The workmanship, as a general thing, was faultless, and the designs and patterns of the frames in very good taste.

The principal exhibitors were:

C. A. Maugin-Lesur.

C. A. MAUGIN-LESUR, of Paris, who made a magnificent display of beveled mirrors set in frames of glass, cut and engraved, with detached, handsome patterns, fastened over the frames by means of screws covered over with

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FRANCE.

Mirrors.

Maugin-Lesur. Lenoir silvering process.

pressed glass heads, hiding the screw-heads. These mirrors were silvered by the Lenoir process, without the use of mercury or tin. A variety of handsome hand-glasses, engraved and cut. A large mirror frame made of cut and fitted strips of blue, ruby, and gilt glass, handsomely cut and engraved. This house displays rare artistic taste in the goods exhibited. I was not asked to look upon any frames with the unfortunate leafage ornamentation of the Italian section among the goods of this house. In fact, none of that style of decoration could be seen in the French section.

D. Brémard.

D. BRÉMARD, of Paris, besides exhibiting a number of finely beveled cut mirrors, set in glass frames, finely engraved and cut, had a handsome and attractive cut-glass frame, containing a clock, a barometer, and a thermometer, the whole front being made of glass except the hands of the clock.

There were also to be seen small plates of glass, cut in bevels, with handsome engraved borders, used as photograph frames.

Lorémy & Rochet.

Glass buffet.

LORÉMY & ROCHET, of Paris, exhibited a parlor cupboard with mirror, being made entirely of silvered plate-glass panels, with decorated shields handsomely cut and engraved. This piece of furniture was also lined inside entirely with silvered plates, with the exception of the shelves, which were of plain plates. This buffet, or cupboard, was surmounted with a beautiful beveled mirror, having a plate-glass frame plated with slabs of blue glass and silvered white glass, cut, engraved, scalloped border, etc. This magnificent but rather fragile object was said to be worth $1,000.

M. Hazard.

M. HAZARD, of Paris. A fine display of glass mirror frames, cut and engraved. Among others, I noticed one with a heavy diamond-cut border, another with a blue-glass cut and engraved border. These frames are mostly ornamented with clear and depolished engraved, silvered and clear-glass plates.

Max J. Fuchs.

MAX J. FUCHS, also of Paris. A variety of toilet boxes made of plate-glass panels; hand-glasses; cut, beveled, convex, and concave mirrors; hand-glasses with enamel decorated borders in handsome designs.

C. Martin.

C. MARTIN, Paris. A beautiful glass mirror with buffet underneath, the panels of which are made of convex clear plate, the bottom of this buffet made of a silvered mirror. A very artistic and handsome piece of furniture; price $750.

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FRANCE.

Mirrors.

Guenne & Gilquin.

VEUVE GUENNE ET GILQUIN, Paris. Besides the usual handsome mirrors set in glass and gilt wooden frames, this firm had quite a number of handsome toilet boxes of thick plate-glass, mounted in gilt metal frames. Also, a small obelisk in solid glass, cut in imitation of the monument of the Place de la Concorde.

Other exhibitors of mirrors.

The following were also exhibitors: C. Buquet, G. Bay, F. J. Baulard, P. M. Compain, Schick-Weiler, A. Miellot, C. Girardin, H. Boucher, E. Paillard, E. Carpentier, E. Radius, A. Benda, all of Paris. Their exhibits consisted of beveled mirrors set in plate-glass frames, depolished and with clear engraving, plated over with cut pieces of plate glass, silvered, colored, or clear white; glass frames decorated in the usual style, but having a black background showing through the glass; wooden frames in white and yellow, in deep dead black, in carved wood, painted white and gilt; mirrors combined with buffets or cupboards; toilet glasses, set three together upon a stand; hand-glasses, plain and decorated; and common mirrors of blown plate, set in plain wooden frames.

Decorated glass.

Decorated glass.

In the decoration of fancy wares with enamel colors, in imitation of antique glass, the French seem to be much ahead of all other nations, excepting, perhaps, the Austrians, who are so well known for their fine decorated glass. The French, however, have produced some work in that line which, I think, cannot be equaled.

P. J. Brocard.

P. J. BROCARD, of Paris, one of the most celebrated decorators, exhibited a variety of vases, bowls, plates, dishes, flagons, goblets, beautifully decorated in different colored enamel and gilded borders. These wares are made in imitation of antique glass, Arabian, Persian, and Roman. They are principally made of a green and brown tinted glass, with raised enamel designs. The conception and execution are in the highest style of art, and though I cannot particularly admire this style of decoration, the wonderful skill of the maker is undeniable. The goods exhibited were nearly all marked sold. I cannot undertake to describe them without the help of illustrations.

Imitation of antique in colored enamels and gilded borders.

Gallé.

GALLÉ, of Nancy, another maker in the same line, exhibited wares decorated in the same style as Brocard, but he also decorates crystal or flint glass in enamels, and with handsome engraving. There was shown a peculiar Arabian vase of clear glass, with cover, decorated in arabesque, finely executed; vases decorated with a combina-

Flint glass decorated in enamel.

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Decorated glass.

tion of engraving and enamel colors. The work of this house is also of a very high order.

Albert Pfulb.

ALBERT PFULB, Paris, also a decorator of antique glass, showed a large Arabian vase from the Alhambra, copied from the original in the museum at Grenada; a very fine piece of work. Bowls, vases, goblets, cups, tumblers, all decorated in enamels of different colors, and in clear and dead gold.

Enameled objects.

E. Rousseau.

E. ROUSSEAU, Paris, had on exhibition Venetian glass ware, painted and decorated, heavily engraved in relief; odd-shaped glasses, painted, enameled, and gilt; oval flattened jugs of a greenish glass; other jugs of the same having a hole in the middle of the body; vases with blue glass borders, and tears distributed over the surface.

Venetian ware.

Ernie.

ERNIE, Paris. Large flower vases decorated in enamels of various colors; a dish with a gold ground, a central portrait, and fancy border; toilet boxes of bluish glass, with painted decorations.

Ch. Brunetti.

CH. BRUNETTI, Paris, had a very handsome display of enameled decorated wares, consisting of colored vases, jugs, lamps, etc., said to have been decorated by the printing process. The execution was remarkably fine, but it is supposed that the defects which naturally would arise in transferring had been corrected by hand. Two handsome vases of opal glass, with a crystal outer coating, containing silver metallic powder, painted in heavy relief enamel colors; vases decorated with landscapes and figures, the work wonderfully well made; bowls, goblets, decanters, cups, decorated in Persian style; ruby pitchers decorated in heavy gold and colored enamels, very handsome; white crystal vases with enamel borders of green, gold, and pink; white crystal light articles decorated in very light designs of enamel; toilet boxes decorated and set in gilt frames; two vases of black glass, with silver powder in the mass, covered over with white crystal, decorated in enamel and dead gold fillets—a very handsome combination; black glass vases with enamel decoration in colors and gold. The decorations of this house are very handsome and superior in execution. I wish to call particular attention to some of the combinations of colors in the wares made of different plated glass. The ruby and opal produce a very pleasant color; enamel colors on ruby are also very handsome. Black vases decorated in gold and raised enamel are to be highly praised. Light patterns on white crystal, with the opaque colors of enamels, are to be encouraged. This house, by its fine display of decorated

Printing-process decoration.

Enameled wares.

Superior execution.

Good choice o colors.

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FRANCE.

Decorated glass.

Ch. Brunetti.

wares by the printing process recently introduced into France, has shown what can be expected of a system which must become popular, owing to the low price and comparative perfection with which these goods can be decorated. I should like to see this method of decoration introduced into this country, where the demand for decorated ware is already great and rapidly increasing, and where the defects naturally inherent to such a system would pass unperceived with the great mass. In my opinion, this style of ornamentation is capable of a wide introduction.

J. B. Villaume.

Etched glass.

J. B. VILLAUME, Pantin, had a very handsome exhibit of etched glass with hydrofluoric acid, consisting of table and fancy articles on plain white and flashed glass. Goblets of blue upon white, etched, representing the celebrated Carpeau group of the Grand Opera front; views of the Trocadéro building of the Exposition; portraits of celebrated men, very finely done; globes; lanterns in flashed colored glass; a looking-glass, etched, representing the wolf and the sheep, with an etched border, the whole silvered over after being etched. The beauty of the work of this house was another example of the handsome ornamentation that can be done on glass by the etching process. I was particularly pleased with the different tones of etching produced on the same object, some entirely depolished, others showing different degrees of clear and semi-clear tones.

Other French exhibitors of decorated glass and glassware.

A. BUCAN & DUPONTIEU, at Creteil; V. BECKER, Pantin; G. TRAUFFLER, Pantin; BOIRRE AINÉ, G. PINCK, M. JEAN, and BUGLET, of Paris, also exhibited very fine enamel decorated wares, such as vases, goblets, tumblers, toilet-boxes, jugs, plate-glass plaques, looking-glass frames with enamel decorated borders, candle lusters, mounted in gilt, and silvered metal *bobèches* (a small disk put on top of the candlestick, with a hole bored through it to admit the candle) of colored glass, cut, gilt and enameled.

Paper weights.

Paper weights of hollow balls filled with water, containing a man with an umbrella. These balls also contain a white powder which, when the paper weight is turned upside down, falls in imitation of a snow storm.

Bronze-enamel vases.

Vases covered over with a peculiar purple bronze-looking enamel, imitating the iridescent colors of glass. Silvered vases, glass balls, and candlesticks. Bunches of grapes, silvered or colored inside in blue, green, and ruby.

Opaque high-relief enamel.

Articles decorated in opaque colors in very high relief. This style of decoration looks well, as it relieves the monotony of a flat surface. Engraved and enameled articles.

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FRANCE.

I am in hopes that some of our manufacturers will devote their attention not only to the printing process I mentioned before, but also to hand decoration with enamel colors. Many very handsome things may be made at a moderate cost. I especially recommend the introduction of this style of decoration on good clear white and bright-colored glass, for I cannot see nor appreciate the beauty there is said to be existing in handsome decorations put upon smoke-colored, dirty green, or muddled glass, in imitation of antique glass ware. The French and Bohemians have shown us what can be done with good glass, and I much prefer the result when compared with the Italian reproductions of antique glass.

Decorated glass.

Attention of our manufacturers recommended to this branch of the art.

English manufacturers have waked up to the beauty of the enamel decorations, and are at work getting out patterns for them. This is one of the benefits of exhibitions, and intelligent nations are not slow to see and adopt improvements.

Glass signs.

Glass signs.

Another use to which glass has been put with much advantage should be mentioned. I refer to ornamental glass letters, cut, gilt, painted, and decorated in handsome patterns. These letters are cemented upon plate-glass and are used for signs. They are made in plain white crystal and flashed-colored glass, cut in diamonds and other patterns, beveled on the edges. Pieces of glass are also cut in the shape of boots, gloves, shields, crosses, medallions—cut, engraved, silvered, and gilt. A fine assortment of these letters was exhibited by Messrs. Petit, Hodin, and Dewez, all of Paris.

Petit, Hodin, Dewez.

Decoration of window glass.

Decorated window glass.

The decoration of window and plate glass with enamel colors is also extensively carried on in France, with very fine results. I have classed the exhibit of Messrs. Lémal-Raquet & Co., of Paris, under this chapter instead of window glass, as I think it more properly belongs here. This house is quite celebrated for the beauty and fine execution of its work. They are the inventors of the flattening oven I have described under the head of window glass.

Lémal-Raquet.

They exhibit curved plates for circular street lanterns; dials of glass covered with opal enamel; pressed glass tiles; sheets of plated glass engraved and ruled in depolished lines by a machine invented by themselves; panes etched with acid and silvered; large panels of glass in ordinary

Curved plates.

Machine-ruled glass.

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FRANCE.

Decorated window glass.

Lémal-Raquet.

gray enamel, colored, transparent, and opaque colors; a large variety of decorated muslin glass, made by mechanical processes of their own, which enable them to do the work at very low prices. While in Paris I visited a factory making similar enameled glass and saw the simplicity of this branch of industry. Yet, in this country, we are almost entirely dependent upon foreign manufacturers for the fine enameled sheet-glass in use in our houses and public buildings.

Enamel colors.

Enamel colors.

Among the manufacturers of enamel and transparent colors I may mention:

A. Lacroix.

A. LACROIX, 184 and 186 Avenue Parmentier, Paris, already well known in this country by our amateur china decorators. M. Lacroix had the kindness to invite me to visit his works, and showed me through his whole establishment. The house was founded in 1855, and the owner has found such a demand for his goods that he has again been obliged to enlarge his works; some parts of the new building were not quite finished at the time of my visit. The works now give employment to 43 persons. Within the last three years the production of his works has been doubled, and in the year 1877 his exportation was also doubled. M. Lacroix manufactures all kinds of vitrifiable transparent colors and enamels, put up in dry powders or in tubes, already mixed, such as are used for china and glass decoration. He also sells little portable furnaces for baking china and glass, with which amateurs may do their own baking at home and thereby save the risk of breakage and cost of transportation. M. Lacroix has been connected with the manufacture of vitrifiable colors for a long while, and is particularly careful in his preparations. I had the pleasure of seeing the different processes through which the preparation of colors has to go: The melting furnaces in which the glass and enamels are first melted; the grinding mills through which these are reduced to powder or paste; the drying ovens; the putting up of powders; and the filling of tubes with wet colors. I was particularly pleased with the cleanliness and neatness of this establishment. I can scarcely add anything to the already well-known and deserved reputation of this house.

Production.

Enamel colors in powders and tubes.

Portable furnaces.

Process.

Appert Brothers.

APPERT FRÈRES, of Paris, also manufacturers of colors and enamels, had a fine display of their productions, consisting of colored enamel disks (Venetian style); enamels for watch and clock dials, for gold and silver, for col-

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ored crystal, in tubes and sticks, for pearls and fancy glass ware; vitrifiable colors for painting on china, glass, and enamel; colored enamels for pipe clay; fluxes of all kinds, melted or precipitated. Quite a variety of goods was shown, being the application of their productions, such as: FRANCE. *Enamel colors.*

Colored glass, coated on both sides, with another color in the middle; the two outside coats engraved, thereby showing three colors. Appert Brothers.

Panels of glass mosaic, as samples of their enamels. Exhibits.
Decorated Venetian glass ware.
Vases, painted, with the necks ornamented with colored beads.
Opal clock dial, with the hour-marks etched.
Imitations of various precious stones, cut in cameos and diamonds.
Colored beads, plain and depolished.
Sheets of plated colored glass, as well as cylinders in all colors.
A fan of spun glass in several colors.
Etruscan vase colored with chrome green.
Two large dishes decorated with their Chinese white.
Enamels on cast and wrought iron.
Chemical glass ware for laboratories.
White and colored chimneys for light-houses.
Rough-cast glass for deck-lights and lenticular apparatus.
Sheet-glass for spectacles and optical purposes, white, blue, neutral, or smoked, rose-colored, with gold-plated opal.

The colors of the glass and enamels exhibited by this house are all very pure and clear.

GUILBERT-MARTIN, at St. Denis, has a manufactory of enamels and colored glass in sticks and tubes, which I had the pleasure of visiting, and saw the operation of drawing the colored tubes. The establishment does not differ from an ordinary glass-house, except in not using annealing furnaces, but simply a melting furnace. At the Exposition I saw samples of their manufactures, consisting of: Guilbert-Martin.

Plaques of enamels in all colors. Exhibits.
Sticks of colored glass, beads, and plaques of mottled marble glass.
Plated sheet-glass in two, three, and four layers of differently colored glass.
Imitation colored precious stones and a series of white strass in fine and brilliant imitation of the diamond; opal clock dials.
A collection of 2,000 tints of colored enamels for gold and silver.
Tubes for levels, water gages, barometers, thermometers, chemical glass ware, etc.

E. PARIS, of Saint Joseph du Bourget, dépôt in Paris, one of the pioneers in the manufacture of enamels, had an exhibit of his wares in a special building, where specimens of his glass ware in plain, colored, and enamel could be seen. The reputation of this house is well established, especially as a maker of enamels for cast and wrought iron. A very fine large iron fountain, colored in blue enamel, was put up in the grounds of the Exposition, and attracted E. Paris. Enamels for metals.

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FRANCE.

much attention. This work showed a remarkable uniformity in color and freedom from cracks. Many large iron flower tubs were also distributed through the grounds; these were enameled and decorated by the printing process, and were the production of this house.

Bottles.

Bottles.

France, owing to her wine production, is naturally a country where bottles are needed in large quantities. Several large glass-houses are especially devoted to the manufacture of bottles.

de Lourches glass-works.

SOCIÉTÉ ANONYME DES VERRERIES DE LOURCHES (*Nord*), was founded in 1851, and is situated in the midst of coal mines. This society has established a special laboratory, where all the materials used are analyzed. They have

Plant.

a 12-horse steam-engine, 3 melting furnaces of 8 pots each, 2 furnaces constantly at work and the other under repair.

Furnaces.

The life of their furnaces is about 10 months. Annual pro-

Production.

duction 3,000,000 bottles, of which one-third are exported. They manufacture wine and liquor bottles, demijohns, and

Workmen.

casks, and employ 90 men, 24 women, and 30 children; together, 144 workmen. They maintain a savings association, and allow 5 per cent. interest upon the amount paid in by the workingmen. Their exhibition consisted of green and brown bottles and a variety of very large glass barrels. These are a speciality with this company.

Deviolaine & Co.

DEVIOLAINE & Co., glass works at Vauxrot (*Aisne*), founded in 1802 at Prémontré, then transferred to Vauxrot in 1828 by the grandfather of the present owners. Bottles are exclusively made, and principally for champagne wine,

Champagne bottles.

which can resis' a pressure of 25 to 30 atmospheres. They also make bottles for beer, mineral waters, and general druggists' ware. The works employ 300 workmen, 50 of

Workmen.

which are from 12 to 16 years old; no women are employed.

Plant.

There are four melting furnaces run with coal, containing 28 pots. For a few years past they have been making experiments with a Ponsard furnace, run with gas and a regenerator. It is expected that, with the improvements that have been made lately, these furnaces will save a great deal of fuel. The annual production of this firm is from four to

Production.

five millions of bottles. Experiments have been made with closed and rotary molds, but are pronounced to be a failure, especially for champagne bottles, in making which it is said that nothing can be substituted for the hand of the workmen. The bottles of this house are especially said to be renowned for their great strength and resistance.

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FRANCE.

Bottles.

A. CHARTIER & Co., at Douai (*Nord*), make green, light and dark black and yellow wine bottles. They had a series of bottles from a very light yellow to a very deep shade, all of excellent color. Fruit jars, demijohns, carboys, etc., all of remarkably uniform color.

A. Chartier & Co.

VERRERIES D'ÉPINAC, at Épinac (*Saône-et-Loire*). Bottles of all kinds. Curiosities exhibited by this firm were a bottle blown in 1611, of brown glass, which had been discolored very much and looked like bronze metal, and another bottle of 1811 in a very good state of preservation.

Épinac glass-works.

J. TUMBEUF NEVEU ET NEVEU, Vieille-Loye (*Jura*). Bottles of different kinds. These works were founded in 1506. It was at this place, in 1630, that the first gentlemen glass blowers (*gentilhommes verriers*) were made by a decree of the king.

J. Tumbeuf.

Other exhibitors were J. Chagot & Co., at Montceau-les-Mines (*Saône-et-Loire*); A. de Granrut aîné, Loivre (*Marne*); E. de Granrut, Maison-Rouge (*Ardennes*); Société Anonyme des Verreries d'Hirson, Hirson (*Aisne*); Verreries de la Loire et du Rhône, Rive-de-Gier; Richarme Frerès, Rive-de-Gier; P. Cretin & Co., Chagny (*Saône-et-Loire*); E. Collignon & Clavon, Trélon (*Nord*); S. Édouard-Roulet, Graville-Sainte-Honorine (*Seine-Inférieure*); Schneider & Co., Decize (*Nièvre*), were also exhibitors of bottles of all kinds, green, brown, and black glass, for wines, champagnes, liquors, beer, etc.; glass bells used to protect early vegetables, demijohns, etc. One firm, Richarme Frères, exhibited demijohns of 460, 380, 343, and 158 liters.

Other exhibitors of bottles.

Stained, engraved, and etched glass.

Stained, engraved, and etched glass.

The art of staining and decorating window and plate glass is carried to a great state of perfection in France, and the artistic taste and skill developed in its execution is really wonderful. It is not my purpose to enter into an artistic discussion of this beautiful branch of the glass industry, but I simply wish to call attention briefly to what is done by French artists in the different styles of ornamentation.

P. BITTERLIN, of Paris, had one of the finest displays. Large panels of plate-glass were hung in an outside gallery, where the light could readily shine through and show every detail of the designs. Several beautiful plates etched in clear and depolished by hydrofluoric acid in different tints of depolish, from dead white to a blue white; also specimens of engraved panels for the handsome building erected in the Exposition by the city of Paris. A peculiar style of etching was shown, said to be a "modification of

P. Bitterlin.

Depolish etching of window-sheets.

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FRANCE.

Stained, engraved, and etched glass.

silicious surfaces by a new combination of hydrofluoric acid," a new patent. This process produces a very rough surface, engraved clear. There is probably a combination of acid with a substance resisting its action, which is applied to the surface of the glass, to protect it in parts only and in irregular spots. The effect is not pretty. This house has combined engraving, etching, painting, staining, and plated or flashed-colored glass in the ornamentation of its panels with a very successful result. Some plates are engraved or etched and filled over with grisaille color; some are etched in depolish on one side and decorated in enamel and vitrified colors on the other. Stained-glass plates are leaded and others painted with lines in imitation of leads. Plates of flashed colored glass etched clear and in depolish. Fine landscapes painted in vitrifiable colors. Vitrified photographs on plain white and on opal grounds. In fact, many happy combinations of colors, engraving, etching, and colored glass are shown with great advantage and success by this house.

Various processes of engraving, etching, dopolishing, and enameling.

Etched flashed colored glass.

Vitrified photographs.

Reygeal Bros., Michon & Veysset.

REYGEAL FRÈRES, MICHON, & VEYSSET, Paris, exhibited plates with a clear glass ground, certain parts etched clear with acid, others in grisaille and dead etching; plates etched in relief and painted in colors; plates of glass of different colors; stained and enameled sheet glass; plated sheets engraved and etched.

J. Dopter.

J. DOPTER, Paris. Glass plates in plated or flashed-colored glass, depolished ground, painted with enamel colors in relief and parts etched clear; some of the same style with faint colors painted between those in relief and the etched designs; sheets of glass with a combination of enamel colors and etching; photographs on glass, with handsome engraved and etched borders.

Photographs on glass.

Ch. Lévêque.

CHARLES LÉVÊQUE, Beauvais (*Oise*), had on exhibition three large leaded windows, representing the history of engraving, printing, and bookbinding, consisting of a series of panels illustrating the different processes of these arts. The colors and drawing were very good.

Stained-glass windows were also exhibited by:

Exhibitors of stained glass windows.

G. NÉRET,	*Paris.*	M. P. QUEYNOUX,	*Paris.*
J. A. PONSIN,	"	C. J. VANTILLARD,	"
L. A. OTTIN,	"	J. B. ANGLADE,	*Condom, (Gers.)*
E. HIRSCH,	"	BAZIN & CO.,	*Mesnil-Saint-Firmin, (Oise,)*
H. CRAPOIX,	"		
G. BOURGEOIS,	"	G. CHAMPIGNEULLE,	*Bar-le-Duc-Salvanges, (Meuse,)*
H. CHABIN,	"		
J. G. GSELL-LAURENT,	"	HÖNER PÈRE ET FILS,	*Nancy, (Meurthe-et-Moselle,)*
L. LEFÊVRE,	"		
P. NICOD,	"	N. LORIN,	*Chartres, (Eure-et-Loir,)*

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FRANCE.

Stained, engraved, and etched glass.

These represented groups, landscapes, portraits, and other subjects, intended for church windows, and were all done in very fine style. But I noticed in several instances that several of the glass pieces were very much deformed by heat in baking the colors.

Didot & Balencio.

A. F. DIDOT & BALENCIE, Paris, exhibited vitrified and enameled photographs in black and brown, very finely done.

J.M.H.Remon

J. M. H. RÉMON, Paris. A series of panels without leads, showing quite a number of subjects, said to be made by a new process, in imitation of stained glass. I do not consider this a very successful style, for the colors looked blurred and the grounds irregular in color. It looked as though it was a painting or printing on thin canvases stuck together by means of a varnish.

Durand.

DURAND, Paris, had on exhibition a panel of plate-glass which appeared to have been engraved and painted over in transparent colors, representing Etruscan patterns. The transparence of the colors over the engraving produces a very pretty effect.

Casset-Delas.

CASSET-DELAS, Paris, displayed etched plate-glass which he calls "plastic etching." This etching shows different degrees of depth in the designs, the ground being clear. It is an imitation of intaglio engraving, but the result is not satisfactory, as the acid in eating away the parts does not work regularly, and the etching appears quite rough and of uneven surface.

A. G. Reyen.

A. G. REYEN, Paris. Window panes engraved by the wheel on blue and ruby flashed glass, representing portraits and other subjects. The work was very superior and the shadows managed with wonderful ability, the tones in clear and half clear of beautiful execution. This evidently was the work of a very superior artist.

Wheel-engraved window panes.

L. Kessler.

L. KESSLER, Paris, said to be the inventor of etching in depolish with hydrofluoric acid and the printing process, had a very large glass vase, the bowl of which was very intricately and handsomely etched, showing great perfection. He is also said to be the inventor of an ink he had on exhibition, which can be used to etch glass with an ordinary pen. This ink is said to attack glass only, and does not destroy pens; quite a convenient article for labeling glass vessels. On a trial of this ink I found, however, that it is very difficult to make fine lines, as it is very thick.

Glass etched in depolish.

Etching-ink.

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GREAT BRITAIN.

The British section contained quite a variety of glass ware, especially table ware and ornamental glass. In point of excellence of metal and workmanship the British were splendidly represented.

Thos. Webb & Sons.

THOMAS WEBB & SONS, Stourbridge and London.

The best flint glass on exhibition.

These exhibitors had the finest display of flint and colored wares, and deserved the grand prize which they received. Their flint glass was the finest in the Exposition, and was superior in brilliancy to the French, which still retains a trace of the bluish tint so noticeable in their glass in 1867. I should mention, however, that other British houses had also very fine flint glass nearly equal to Webbs'. In fact, all the flint we saw in that section was of remarkably good quality, and superior to that exhibited by other nations.

Grand gold medal.

General excellence of British flint glass.

Vases and ornamental glass.

Vases and ornamented glass.

The display by Webb & Sons comprised a multitude of handsome articles. The center of attraction seemed to be a vase in the style of the Portland Vase, called the Dennis Vase.

"Dennis" vase.

Northwood.

The body of this vase is of a very dark blue and coated outside with opal glass. The subject chosen by the artist, Mr. Northwood, is the Triumph of Galatea and Aurora. The cover represents a winged horse, not yet finished. The two handles represent horse's heads, one of which is finished. The subjects shown upon the sides, the base, and foot are ornamented with leaves in opal. The immense difficulty of producing such an article will be understood when it is considered that all the designs in relief have to be carved and chiseled out of the white outside coating; the artist is required to produce a semi-translucid effect, showing the blue glass through the opal, carving out this glass and making it thin enough to show the blue through and yet retain perfect and correct relief forms. This beautiful effect was reproduced in several parts of the vase. The blowing of the vase itself must have been a difficult piece of workmanship, since the horse on the cover and the horse-head handles must have been so put on as to enable the artist to carve correct subjects and introduce the semi-transparent tints I have alluded to. This glass carving is necessarily a very slow work; the vase is not yet finished, some parts being polished and others yet in the rough state. The artist has already devoted two years to the vase, and it is estimated it will be worth $15,000 when finished. It is simply a "*tour de force.*"

Woodall.

Next to this vase a smaller one of the same style was exhibited as the work of Mr. Woodall. The subject represented is after Guido's Aurora. The skill displayed by the artist commands admiration. The half tints described in the former vase were also produced in this vase

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GREAT BRITAIN.

with remarkable effect. The base shows a series of leaves, with the semi-transparence repeated in each with a surprising evenness of shade. The parts, after having been carved, may be left rough or may be polished; this enables the artist to obtain a dead or clear effect.

Thos. Webb & Sons.

A striking feature of the Messrs. Webb's exhibit was their engraved flint articles such as decanters, vases, ewers, jugs (Figs. 11 and 12), dishes, trays, goblets, etc.

FIG. 11.—*Thomas Webb & Sons.*

FIG. 12.—*Thomas Webb & Sons.*

Engraved flint glass.

Kny.

A vase engraved in relief by Mr. Kny was a marvel of execution; only nine inches high; it is valued at $1,500. The engraving around the body of the vase was partly clear and partly depolished, and was beautifully executed. It stood in such bold relief that, though engraved by the wheel, it might be supposed to have been carved.

A decanter, Fig. 13, also engraved by this artist, the subject representing the frieze of the Parthenon in intaglio half-clear engraving, was very beautiful. It is valued at $2,250.

In flint metal several other interesting articles, engraved in dead and clear surface, were exhibited:

A plate representing Venus Aphrodite, a beautiful piece of work, valued at $150.

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GREAT BRITAIN.

A vase in the Italian Renaissance, with classical subjects, handles, and foot engraved, worth $1,000. I noticed in this vase a very pretty effect made up by polishing diminitive spots on the dead engraved ground. The brillancy of these points on a dead surface I consider a very happy effect.

Thos. Webb & Sons.

A two-handled jug, subject Pluto carrying away Proserpine, engraved very deeply on the two handles, with

Vase in intaglio half-clear engraving.

Renaissance vase in engraved glass.

FIG. 13.—*Thomas Webb & Sons.*

FIG. 14.—*Thomas Webb & Sons.*

the base of each ending in an engraved medallion; all of beautiful workmanship; valued at $500.

Vases at $200; jugs at $500.

An endless variety of table-service articles, such as jugs with the peculiar shell handle which is now pressed by our manufacturers.

Fig. 14, part of a water service in the Italian Renaissance style, shows the most beautiful designs and intricate ornamentation. The whole of the surface, and even the handle, is most beautifully engraved. The principal designs represent four Cupids in different attitudes, graceful birds, and fine tracery.

Engraving of all kinds, combined with clear, half-clear, and dead surfaces, on tankards, mugs, goblets, decanters. Many of these articles are engraved very deeply, and the engraving is subsequently polished. Such articles were also shown in the French section, but it is apparent that too much labor is bestowed on such work without corresponding effect, since the reflection of light somewhat drowns the designs.

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GREAT BRITAIN.

A very handsome square jewelry casket made of plate-glass, with a gilt frame and four handsome columns with solid ball bases in the corners, the sides cut in deep diamonds and engraved escutcheons.

Thos. Webb & Sons.

Heavily cut sets (Figure 15) in spiral bamboo and diamonds, heavy and brilliant sets of blue and pink upon flint, cut in relief, with projecting knobs upon which the colored glass has been left, but subsequently cut in diamonds upon their faces; sometimes borders of colored metal are left and cut over in the same style.

Bamboo and diamond cut decanter.

Large bowls, decanters, fruit dishes, goblets, etc.

Some sets of ruby upon flint, of very handsome shades of ruby.

Decanters with stoppers cut in prisms, which make a beautiful play of colors.

A large variety of flower stands in flint and ruby, cut in large diamonds, upon which smaller and very fine diamonds were cut; most of these articles are mounted on gilt metal stands.

FIG. 15.—*Thomas Webb & Son.*

Iridescent glass.

Iridescent glass.

This house is also manufacturing iridescent flint glass in thin blown articles, such as decanters, goblets, jugs, and flower stands, mounted on mirrors, the base of these stands being made of solid balls. The use of these balls adds very much to the beauty of light fancy articles, besides the safety it adds in keeping them from falling over.

Flower stands.

A very attractive style of flower stands is peculiar to this house. It consists in making receptacles for flowers with sticks of flint glass mounted in the style of our log cabins; they are held together by means of silvered wires. These are built of different shapes, and lined inside with a galvanized metal casing. Quite a number of these stands were made of bronze iridescent glass of very pretty colors.

Bronze iridescent glass.

This bronze iridescent glass is a speciality of this house, said to have been patented, and was quite new. The first samples I saw were not quite satisfactory, as the glass looked rough on the surface and the colors were dark, without brilliancy. The new samples received, however, were very handsome; the glass retained its usual brilliancy, and reflected the iridescent colors in pleasing variety. Jugs made of this glass were engraved to show the ground of the

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GREAT BRITAIN.

Thos. Webb & Sons.

glass, while the remainder was kept in the polished state. The bronze of this glass has a peculiar greenish tint prevailing through the mass.

Chandeliers.

Chandeliers.

Of chandeliers the Messrs. Webb had a very fine collection.

One particularly, in the center of their exhibit, was a specimen in very good taste. The bottom piece is a large ribbed hollow ball, with

Engraved glass jug.

FIG. 16.—*Thomas Webb & Sons.*

twisted glass branches starting from the middle. The center stem is made up of a series of these balls, decreasing in size towards the top. The drops are made of blown hollow glass, prettily shaped. Between the series of balls the center stem is made in the shape of a handsome vase. Attached to the bottom of the drops are several solid glass

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balls containing a number of little air bubbles. One of the balls, a very large one, was hung to the bottom of the chandelier. GREAT BRITAIN.

Other chandeliers, of flint and colored glass, were hung through their show temple. All of them were of very good taste and fine execution. Thos. Webb & Sons.

Some made for candles had long solid branches, with heavily cut bowl for bottom pieces, and solid prismatic cut buttons attached.

The tops of some chandeliers were made of inverted cups, cut in scallops Some of the drops were made in the shape of square pyramids of solid glass, running to a very sharp point. The whole chandelier was made of a mass of clear and heavily cut glass, in which colors played most beautifully. Some others were mounted in gilt or silvered metal. Chandeliers.

Engraved glass jug.

FIG. 17.—*Thomas Webb & Sons.*

A very pretty combination of white and colored glass was to be seen in several of their chandeliers; drops of colored and white glass, some tear-shaped, some depolished, and others cut.

A large variety of side brackets for gas and candles, in the same style as the chandeliers described.

Quite a number of hanging glass flower-baskets, of an infinity of patterns, made of white glass; mirrors and white and colored glass sticks mounted on the outside. Hanging glass flower-baskets.

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GREAT BRITAIN.

Thos. Webb & Sons.

The use of silvered mirrors has been put to a good advantage by this house in combining panels of mirrors into different-shaped stands, baskets, etc., which look very beautiful.

Venetian glass.

Venetian glass.

This firm made a fine display of "Venetian" glass ware. The workmanship, the purity of the flint and colored glass, and the regularity of forms far outstripped anything which could be seen in the Italian section. Nor should I be silent upon the remarkable sets designed by Mr. O'Fallon, a young gentleman who has charge of the decorative and drafting department of this house. Through his kindness I obtained a great deal of information in regard to the wares exhibited. Among his designs I noticed especially some decanters, jugs, bowls, goblets, engraved in the Celtic style, a peculiar ornamentation which he has carried to quite a success. This style of decoration consists principally of engraved continuous lines, in which the ends can scarcely ever be found. The engraving is not deep, but is made up of an endless variety of lines.

O'Fallon.

Celtic style of engraving.

Engraved decanter.

FIG. 18.—*Green & Nephew.*

Mr. O'Fallon has also designed some very comical subjects, such as a pig ornamentally treated, tadpoles, frogs, etc., which, however, I must frankly say, I do not think will ever enter extensively into the race for ornamentation of glass. Although I have seen beautiful classic designs by this gentleman, I regret to find that the shapes of old jugs, tankards, etc., have too often been selected by him. I wish that English glass, which is so commendable for its beautiful workmanship, could be designed in better styles. Mr. O'Fallon is evidently quite talented, as could be seen by some of the beautiful designs of his classic wares, but, as in the Austrian department, the English would be better off by leaving aside the awkward and ugly designs of old mugs, jugs, tankards, etc., a style representing the remnant of the first efforts in ornamentation of half-civilized nations.

Humorous subjects.

Imitations of ancient awkwardness.

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In support of my remarks, I would call attention to these beautifully engraved wares, representing the highest skill and beauty of design, unfortunately placed upon ugly-shaped jugs; Figs. 16 and 17. The same talent, placed upon shapely articles, would look infinitely handsomer.

I also wish to say that if other manufacturers would imitate the Messrs. Webb by sending with their goods men like Mr. O'Fallon, courteous, intelligent, and capable of giving information, they certainly would not be the losers in their reputation, and would increase their trade. All the employés of the Messrs. Webb were, in fact, ready at any time to furnish the information asked, and were uniformly communicative.

Thos. Webb & Sons.

Engraved decanter.

FIG. 19.—*Green & Nephew.*

JAMES GREEN & NEPHEW, London.

Green & Nephew.

A very fine exhibit of table and ornamental glass ware was made by this firm.

Table and ornamental glass, etc.

In the middle of their stand could be seen a very handsome chandelier, a mass of prismatic cut drops, with a very large ball of glass at the bottom, the different parts mounted in ormolu.

Very handsome candelabra, mounted in ormolu, and consisting of solid pieces of glass, pear-shaped, and cut in prisms, a cutting which is particularly well adapted to the fine metal made by this house.

A large square flagon cut in heavy diamonds; worth $50.

A variety of heavily cut hanging baskets, some with separate handles, cut all over and attached by ormolu mountings.

Fruit dishes heavily and intricately cut.

Jugs and decanters, beautifully engraved (Figs. 18 and 19).

A few articles of thin blown glass, etched by acid.

These thin wares, or muslin glass, as it is called, were very well done.

Jugs and goblets, engraved in half-clear engravings.

Paper weights, cut and engraved.

Chandeliers with hollow ball drops, filled with a pink liquid.

Imitation of jewels in glass, in very fine colors.

Also thin muslin iridescent glass fancy articles of a peculiar nature, with small whitish spots.

A few articles of Venetian glass ware in very good style.

Quite a number of mirror flower stands.

Mugs made with spiral air tubes.

Caskets of plate glass for jewelry, engraved and mounted in ormolu.

This house has a very creditable display of fine wares, but is especially noted for making objects of solid pieces of glass cut in prisms—a very beautiful effect.

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Alex. Jenkinson.

This house is especially celebrated for its thin muslin glass and Venetian ware:

Engravings executed upon goblets so thin that it seemed almost impossible to touch them with the engraving wheel without going through.

Muslin glass and Venetian ware.

A striking example of what the glass-blower can produce was a goblet the weight of which, in handling, could scarcely be felt; the bowl was 8 inches in diameter by 8 inches high, the stem 4 inches, the whole weighing 6¾ ounces. This certainly was the thinnest article for its size.

A striking piece of skill was a basket made of bent pieces of glass, handles and all in perfect imitation of wicker-work.

"Venus" vase.

FIG. 20.—*Hodgetts, Richardson, & Son.*

Their imitation of Venetian glass in all styles is certainly, like that of the Webbs, superior to the Italian.

A very handsome set of muslin iridescent glass, which was said to have been sold 130 times.

Very finely cut and engraved glass.

The productions of this house are certainly very superior.

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Like the Webbs, this house had some very fine basso-relievo carved glass in white upon a deep-colored ground: Hodgetts, Richardson, & Son.

A large vase, subject "Hercules restoring Alcestis to her husband."

A pair of two-handled vases, subject Venus (Fig. 20), and another vase (Fig. 21) representing Cupid. Basso-relievo carved glass.

A copy of the Portland Vase, worth $2,100.

These so-called carved glass objects were finely executed, and reflect much credit on this house.

Flower stands with queerly twisted branches.

A tripod with pink sticks and pot hung by glass chain.

Vases of blue upon flint, etched in dead surface by acid.

Handsome flint articles cut in very fine diamonds.

A set of white glass with small threads of bluish green spun spirally upon the surface, the top ornamented with small buttons of the same colored glass.

FIG. 21.—*Hodgetts, Richardson, & Son.*

The usual variety of hanging baskets, flower stands, decanters, goblets, with spun colored threads.

Articles of a peculiarly darkish-green colored glass, said to be a particular production of this house, but little different from bottle glass.

A bouquet-holder in white glass, representing an umbrella with pink border, half opened, hanging upon three branches. "Cupid" vase.

Light pink upon flint plates, etched in acid.

Vases of pink upon opal and ruby upon opal, looking very pretty.

A pretty cage made of pink glass sticks with a looking-glass on the outside of the bottom.

Small tea sets, blue upon white, finely etched in acid, leaving blue in relief.

Several vases of blue upon opal, also etched in acid, showing the design in opal.

Dark blue vase topped with opal, subject Hercules, finely executed, the half tones being very beautiful.

A fine Etruscan vase (Fig. 22) with twisted glass handles, finely engraved.

The acid etching of this house is particularly pretty and skillfully executed.

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GREAT BRITAIN. *JAMES POWELL & SONS, London.*

James Powell & Sons.

This house has quite a reputation for its Venetian ware, and had a great variety on exhibition:

Very fine thin muslin glasses, plain and engraved.

Venetian ware.

Several articles of "metallized" ware in the same style as seen in the Austrian section.

Articles curved spirally with spun threads of colored glass.

A beautiful cube of flint glass, measuring 4½ inches square, of very pure and brilliant metal; not altogether free from striæ, however.

Two large buttons of glass, diamond-shaped, cut in deep prisms.

A remarkably thin blown goblet of 4½ by 5½ inches.

Etruscan vase.

Finely engraved sets with the peculiar English ribbed shell feet, which have been introduced here since our Centennial Exhibition.

The wares of this house are also commendable for good quality and fine execution.

F. & C. Osler.

F. & C. OSLER, Birmingham.

A great deal of attention of the visitors was attracted to their handsome and unique style of glass furniture, chandeliers, lamps, table ware, etc:

Candelabra.

FIG. 22.—*Hodgetts, Richardson, & Son.*

Two candelabra, 3 feet 6 inches high, consisting of a thin triangular prism cemented to a very ornamentally cut foot and topped by six glass branches and a center light (Fig. 23). The form is very elegant and of a striking design. These candelabra are said to be worth $300 each.

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GREAT BRITAIN.

Other very handsome cut-glass candelabra were of an entirely different design, the central shaft being a massive piece of glass richly cut. From the lower part of this shaft, leading up to and being connected with a broad band of gilt metal set with cut-glass panels, are placed branches having glass dishes at the end.

F. & C. Osler.

Twenty richly cut glass drops hung from this metal band. This is a handsome harmony of glass and gilt metal, and is said to be worth $1,200.

Chandelier.

The most striking and handsomest piece exhibited by this firm, however, was a large chandelier of flint glass about 12 feet deep and 7 feet 9 inches in diameter. The central shaft consists of a cylinder in very heavy and finely cut glass; this is surrounded by six smaller shafts, ending at the base and summit in scrolls, from which handsome solid glass pendants are suspended. The inner cylinder opens at top and bottom into floral ornaments; at the base of the shaft is hung a large solid ball of glass, beautifully cut; the branches, hollow—used as gas pipes—are twelve in number, and are a marvel of execution, being made each in one piece of glass 6 feet long, bending gracefully outward at quite a distance. It is impossible to convey an idea of the elegance and finish of this masterpiece, even with the accompanying cut (Fig. 24). It must be seen to be appreciated. It was conceded to the writer by the manager of the first glass works in France to be the most astonishing production yet made anywhere in that line. This handsome chandelier is valued at $4,750.

Glass chair.

Another article of this house also displays very fine and finished execution, but I doubt whether this branch of glass-making will ever be extensively introduced. I refer to a chair of state made entirely of glass; it is about 4 feet in length and height, the whole made of solid glass, beautifully cut. I had occasion to judge of the thoroughness of the work of this firm. One of the gentlemen of the jury representing England said to me, in speaking of the glass-cutting machine (of the writer), that he could show work done by hand which equaled the machine-cut in regularity. Naturally, the work of the Messrs. Osler was selected and the chair pointed out. After a careful examination of the glass buttons upon the end of the arm-rest, several irregularities in the cutting of the facets were discovered, but it must be frankly acknowledged that it required a strict and close examination to detect them, such was the superiority of the workmanship.

Gothic cabinet.

The center piece of attraction was the "cabinet" made of glass in the Gothic style. The extreme breadth is 8 feet 6 inches, and the total height 14 feet 6 inches. I cannot possibly describe this beautiful piece of furniture, as it would be impossible to even give an idea of its effect. It is composed of several very finely cut pieces of glass adjusted over a frame of ebonized wood. It is valued at $11,000.

Questionable use of glass in furniture construction.

Although this handsome piece of furniture is certainly remarkable, I do not believe that glass, as a general thing, can be applied exclusively to the ornamentation of furniture, although plaques, panels, and detached pieces can be used with very good effect. Not the least to mention among the exhibits of this house were a number of cut-glass goblets, flower-stands, decanters, hanging baskets, oil-lamps, engraved globes, all done in the very best style.

A. B. Daniell & Son.

A. B. DANIELL & SON, London.

Reproduction of the Portland vase.

A reproduction of the celebrated Portland Vase, by John Northwood, who worked three years upon it; valued at

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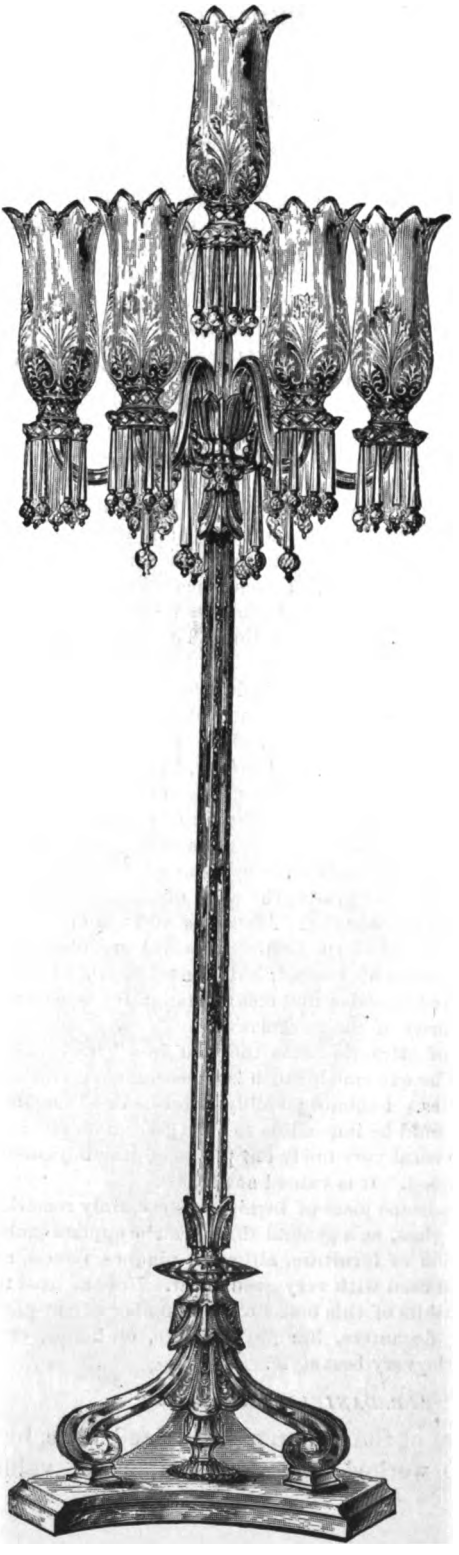

FIG. 23.
F. & C. Osler.

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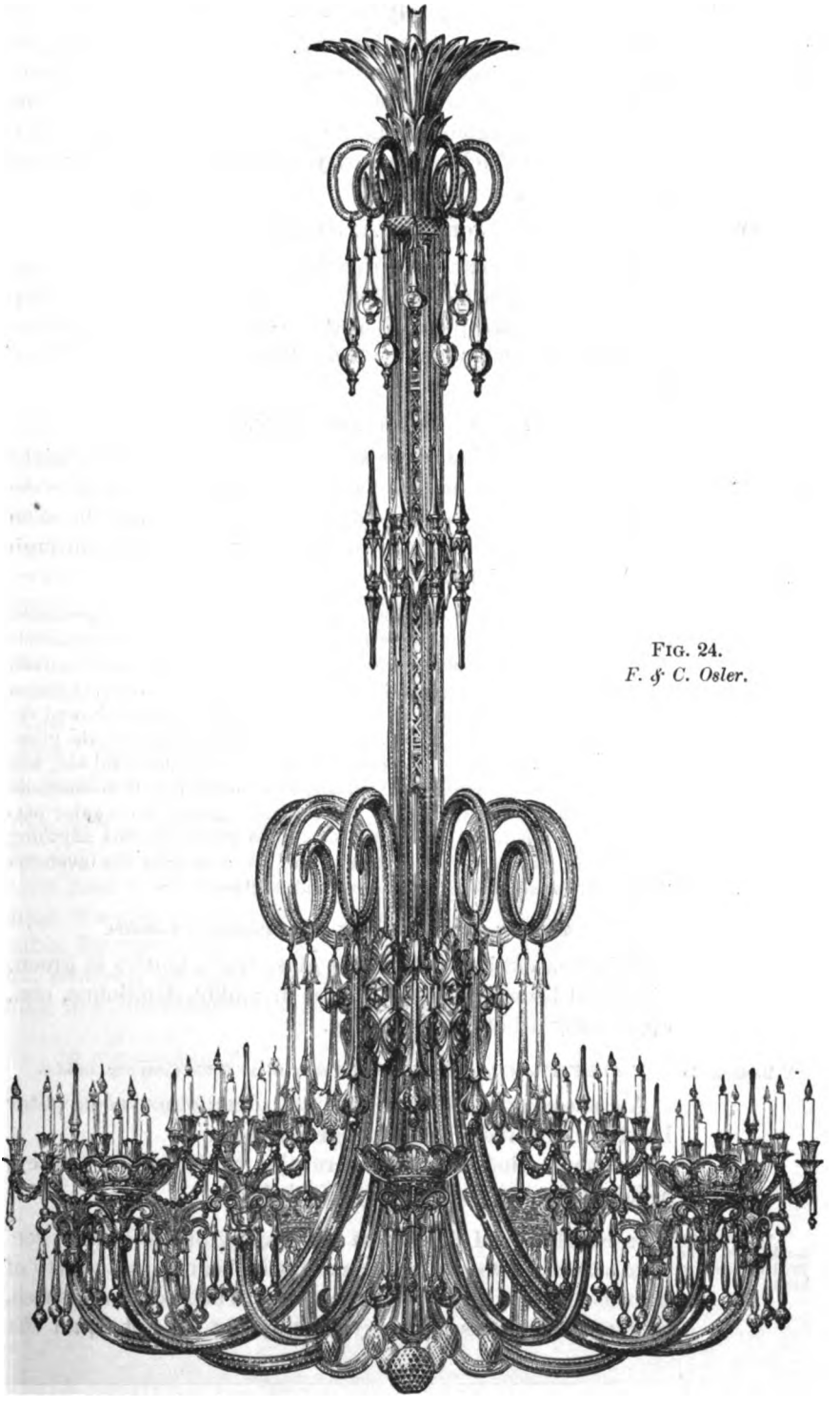

FIG. 24.
F. & C. Osler.

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GREAT BRITAIN.

at $7,300. Unfortunately this vase is cracked on the outside opal glass coating. This house displays quite a variety of spirally spun threaded wares in very fine threads, closely run together; a variety of thin goblets blown round, but shaped into octagons at the edge by being pinched with a suitable tool; finely engraved jugs in clear, half-clear, and dead surfaces.

A. B. Daniell & Son.

John Millar & Co.

JOHN MILLAR & CO., Edinburgh.

A very handsomely engraved jug, representing the Canterbury Pilgrims, worth $150, which I consider quite cheap for such a skillful piece of work; handsomely cut decanters of superior workmanship; very thin blown wares, also of good execution.

Aurora Glass Co.

THE AURORA GLASS COMPANY, London.

Metallized glass.

In the cases of this company could be seen a great variety of small fancy vases in "metallized glass." These were made of different colored glasses, in which could be seen metal flakes of gold and platina distributed unevenly through the body of the glass.

The metals used are principally white and yellow. It is presumed these metals are reduced to powder or thin leaves, and when the article is in process of manufacture the glass is rolled in this metallic dust, which then adheres to the glass, and, by reheating, the article is finished in the usual way. A piece of broken glass of this variety showed the metals to be near the outer surface and slightly sunk into the glass. Although the inventor holds his discovery to be a wonderful one, and attached ridiculous prices on his goods, I see nothing in it to commend it as a valuable process in the decoration of glass. No regular patterns can be produced, and at best this glass will never look anything else than an accidental decoration. The inventor calls the invention "precious metals melted and incrustated in glass."

Kilner Bros.

KILNER BROS., Thornhill-Lees and Conisboro', Yorkshire.

This firm exhibited druggist glass ware, bottles in green, blue, and brown glass, all blown in molds, demijohns, etc., apparently all of good quality.

E. Breffit & Co.

E. BREFFIT & CO., of the Aire and Calder Glass Bottle Company, London.

An assortment of bottles, jars, demijohns, soda-water bottles, in ordinary blue and green glass.

The same kind of goods were also exhibited by Bagley, Wild, & Co., of Knottingley, Yorkshire.

General remarks on the British glass exhibit.

In conclusion, I think that the display in the British section was equal to any other exhibit in beauty and purity of flint metal, in skill, and in execution. Their colored glasses, in many instances, are very pretty, but do not equal the

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French and Austrian, as a general thing. A striking feature of this section was the regularity and perfection of the work, either in blowing, cutting, or wheel-engraving. In the latter, especially, I think they are up with the Austrians, and in some instances, as in their relief engravings, they cannot be surpassed. In cutting, I have found in this section the best work, the most regular, and the most brilliant; above the French, Austrian, and Belgian, in my opinion. In blowing, the regularity of their articles is surprising, considering, especially, that the British workmen refuse to use molds of any kind in working. I admired the unerring perfection of the handles on jugs, vases, decanters, etc.; the beauty of the thin muslin glasses; in the "Venetian" wares the great superiority of their work and color of glass over the Italian.

Regularity of the blowing, cutting, and engraving.

Superior to the continental.

Perfection of details.

I cannot, however, always praise the taste shown in some of their designs. The forms are often heavy, awkward, and wanting in harmonious lines; in this the Austrians, and especially the French, are superior to them. On the question of prices I have been repeatedly assured that British glass is much higher than the French, Belgian, and Austrian. In fancy goods, except in the case of one or two houses, where strikingly beautiful and novel articles could be seen, I do not think that they are quite up to the mark with the French or Austrian. As a whole, the British exhibit was quite satisfactory, and the art of glass-making with them has made very rapid and striking progress of late years.

Taste in designing inferior to the French and Austrian.

In relation to British and continental prices.

I regret that British manufacturers of window and plate glass did not think of exhibiting, as they are well known for the good work they turn out in both of these branches. I think it a great mistake with manufacturers to neglect to exhibit, for many visitors, having seen very fine goods in other sections, are naturally led to believe that the country failing to exhibit does not make that class of goods.

No British exhibit of window and plate glass.

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But few of the Austrian manufacturers exhibited. There was, however, a sufficient display to form an idea of the skill, beauty, elegance, and perfection of the Austrian glass ware. When such houses as J. & L. Lobmeyr, of Vienna, exhibit their wares, we may well form an opinion of the state of perfection to which glass making has attained in Austria. The Austrian section, one of the most attractive in the Exhibition, contained a very fine display of the well-known Bohemian glass ware. This glass, the so-called "crystal," contains no lead or but little, and is a silicate of potash. It cannot compete with the English and French flint in brilliancy, owing to the absence or the very small proportion of lead it contains; but in purity, whiteness, and homogeneity of metal it is the best white glass made in Europe.

Bohemian glass.

Crystal glass.

J. & L. Lobmeyr.

J. & L. LOBMEYR, Vienna.

One-half of the Austrian department was occupied by Lobmeyr, where all the beauty and the wonders of the Bohemian art glass were concentrated. I scarcely knew which to admire the most, the finely cut and engraved crystal objects, or the great variety and diversity of beautifully engraved and decorated articles.

Admirable exhibit.

Among the thousands of attractive objects exhibited by this house I particularly noticed:

List of articles exhibited.

A magnificently engraved bowl, 13 inches in diameter, mounted in ormolu, costing $4,000, given by this house to the Vienna Museum.

A great variety of plates engraved in the most perfect manner, such as the Bohemians particularly excel in.

A large variety of small bouquet-holders, some of them having a foot made of three or more solid balls.

A number of small fancy articles having spirals made of tubes inclosed between two layers of glass. The air inclosed in the tubes resembles silvered threads imbedded in the metal.

Large cut candelabras mounted in ormolu.

Upon a beautiful table of dark blue glass, 3 by 3 feet, about ¾ inch thick, was mounted a tankard of crystal glass cut in bamboos, diamonds, and bamboos intermixed with clear and polished engraving. Alongside of this tankard was placed a goblet engraved in polished engraving, with the double-headed eagle of Austria. Both of these objects were mounted in very tasteful frames of ormolu, studded with clusters of pearls and corals; the metallic handle of this tankard represented a dragon; in the cover were inserted clusters of pearls, coral, and precious stones. The waiter upon which these two pieces were placed was composed of 18 panels, beautifully engraved; the frame and handles of ormolu, the handles representing two beautiful statues. This set, remarkable for its masterly execution, was intended for the city hall of

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Vienna. I cannot say, however, that I particularly admired the design, as to me it seemed heavy and awkward. AUSTRIA-HUNGARY.

Several services of crystal cut glass, painted in black colors of different patterns, were also exhibited. The contrast of a brilliant surface with black decorations I consider a bad effect, not pleasant to the eye. Other services cut and painted in light pink looked very handsome. J. & L. Lobmeyr.

Articles of white glass engraved, and covered over the engraving with a dead gilding, looked very pretty.

Sets of bluish opal glass painted with white enamel and gold.

Sets of white and yellow glass, in which flakes of white mica have been distributed irregularly.

Sets in turquoise-blue, gilt, and mounted in ormolu.

Fine large vases, subjects painted with gold and colored grounds.

Two very large vases in six pieces, measuring 51 inches, with pedestals; the body of the vase handsomely engraved, and the remainder cut; valued at $3,200 the pair. The different pieces were adjusted one upon the other with such nicety that it was with difficulty one could see the separation. Two handsome glass handles were attached at the sides, and were very regularly put on.

Two heavily cut oval bowls, 10 by 15½ inches, cut in diamonds, worth $100 each.

The Austrian cutting is principally flutes and diamonds; sometimes large panels are cut, and upon these heavy sharp diamonds are distributed. Cut-glass.

The thin blown glass ware of this house is very well done. Blown glass.

Quite a variety of goods exhibited by this house consist of articles with cutting, painting, and decorations upon the same article. This would indicate that Bohemian glass is hard enough to retain the sharpness of the cutting, even when it is placed in a muffle to bake on the enamels, the gilding, and other decorations. Decorated cut-glass.

In colored glass I found a large variety of very superior colored, painted, gilded, enameled, and otherwise decorated articles, all executed in very fine taste, and the colors of the glass excellent. Colored glass.

Two fine vases with ormolu handles, 24 inches high by 11 inches diameter.

An opal set of enameled glass painted over in several colors, making a fine contrast.

A very handsome vase, 4 feet high, of iridescent amber glass, gilded and enameled in white, was sold to the Dublin Museum for $140. Another one of the same style was sold to the South Kensington Museum, of London.

Iridescent glass. Iridescent glass.

This house is especially celebrated for its iridescent glass, being the pioneer in that line. About twenty years ago it so happened that by using fire works in a furnace where some glass-ware had been placed the metallic vapors of these fire works produced a peculiar iridescent color upon

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AUSTRIA-HUNGARY.

the glass. It is only three years ago since these gentlemen revived this process, improved it, and put it into general use, with such good results. Other Austrian manufacturers have taken up this process; the English also have obtained good results with it. These beautiful colors of the rainbow were applied principally to crystal glass, but also to several kinds of slightly colored glass, such a slight amber, etc. The Austrian wares in that line cannot be surpassed.

J. & L. Lobmeyr.

Iridescent glass.

Chandeliers.

Chandeliers.

The glass chandeliers exhibited by Lobmeyr were very handsome, light in structure, pretty in design, and skillfully made; they were in striking contrast to the jumble of colors and great number of pieces found in the Italian chandeliers. Some were mounted in gilt bronze, others entirely of crystal glass, plain white or iridescent; some mounted with large and beautiful cut drops of all sizes and shapes; some with cut bowls and branches, others with engraved bowls and plain branches.

Paper weights.

I should not forget to call attention to several paper weights made of a solid piece of glass cut in the shape of a diamond and supported by four little negroes in bronze. The purity and brilliancy of the glass enables one to judge of the perfection of this Bohemian metal, which was almost entirely free from defects.

The fancy articles were in such an endless variety that it is impossible to describe them. I must pay a tribute to the elegance of design, the regularity, and perfection of the articles exhibited by the Messrs. Lobmeyr.

I have to state, however, that, no matter how skillful and beautiful the engraving and decorating of this house may be, the cutting lacks in perfection, and I saw many articles beautifully decorated but very irregularly cut; nor is the cutting deep enough, nor does it present as sharp angles as I saw in the British section.

Enamel decorated ware.

Enamel decorated ware.

The Messrs. Lobmeyr have also attempted the manufacture of enamel decorated ware in the Arabian style.

Arabian style.

The accompanying illustration (Plate 17) represents a few of the styles exhibited. Although the workmanship is good and well executed as an imitation of original Arabic wares, yet the general effect produced by the combination of peculiarly colored glass and the profuse ornamentation is somewhat garish.

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But, however pretty this style of glass may be thought to be by some, in my opinion it will never have a wide circulation. There is oddity about the style, but nothing pretty, and it is only in the hands of such an artist as Brocard or Gallé, of France, that these wares can be made somewhat attractive. Although I have praised the general excellence of the wares of this house, and the fine taste displayed in their designs, from this general approval I must except the uncouth and heavy shapeless articles made in imitation of the old German tankards, mugs, etc. There are no beauty of contour, prettiness of form, or harmonious and pleasant lines; they are, in my estimation, simply the result of the first effort of a nation which has never been singled out for taste, and Bohemian art glass does not receive any additional credit for the production of such wares. The glass decorated by the Messrs. Lobmeyr is manufactured by M. Lobmeyr's nephew, at Adolf, in Bohemia.

J. & L. Lobmeyr.

Arabian style.

Uncouth German objects.

Bohemian glass ware, such as is sent to this country, is often far from being anything above ordinary common wares, but we should not form an opinion of Bohemian glass manufacture until we see such a display as was made by these gentlemen.

The Austrians, in matters of taste, are the French of Germany.

G. Ullrich.

G. ULLRICH, Wilhelmsthal.

A very fine assortment of decorated, painted, and gilt glass.

A very handsome set of crystal glass vases, goblets, bowls, etc., heavily cut, gilt, and with heavy panels left in relief, painted and enameled.

Several large vases in very heavy diamond cutting.

Several articles of iridescent glass, and a few with mica flakes, called "metallized glass." Some of the iridescent glass is decorated and enameled in white.

A very large white glass bowl mounted in gilt bronze.

Articles in crystal glass, cut, covered over with ruby in certain parts, and engraved.

Articles of black iridescent glass, enameled over in white enamel. A very pretty contrast.

Thin muslin glass, blown very regularly, engraved, and painted with light stars and strawberry designs.

Thin articles decorated with light and tasteful designs.

Large vases decorated handsomely with raised enameled borders on light-brown ground. A very handsome effect.

Thin articles of white iridescent glass, with decorations made to imitate crackled glass; these are supposed to have been painted with a medium upon which powdered glass had been sprinkled, then baked in the muffle.

An assortment of handsome chandeliers.

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JULIUS MÜHLHAUS & CO., Haida, Bohemia.

Julius Mühlhaus & Co.

A large, fine étagère with two bowls, handsomely cut and scalloped, the outside of the bowls cut into very sharp angles, which are themselves cut into profiles, in the same style as the small thermometers, representing columns, etc., so that from the inside different cut designs could be seen as if in relief; a very difficult and pretty piece of work; the foot is cut in heavy panels. A handsome piece of cut glass, worth $85.

An assortment of the usual iridescent decorated glass.

Two very large and handsome vases, decorated in white enamel, of beautiful design. A handsome and remarkable piece of work worth $1,150.

J. J. GÜRTLER & SONS, Meistersdorf, Bohemia.

J. J. Gürtler & Sons.

A very handsome goblet, upon which was deeply engraved a representation of the Lord's Supper, in old Bohemian style.

Black vases with white mica distributed in the mass and painted over.

Black vases with golden metallic flakes. These pieces are made by first blowing an object in the desired colored glass; the metallic flakes are then rolled on, and a new layer or envelope is put over this; these flakes are therefore inclosed between the two layers of glass.

CLEMENS RASCH, Ulrichsthal and Meistersdorf.

Clemens Rasch.

A variety of colored decorated glass.

A very pretty pale amber service, engraved; also one in light pink; both of very pure colors.

The usual variety of decorated vases.

A new style of frosted pink vases on an opal inner coat, ground in parts to show the opal coating, and engraved upon the pink outer coat. This style is said to have been recently patented.

Black vases decorated in white enamel, and a variety of iridescent glass.

LUDWIG MOSER, Carlsbad.

Ludwig Moser.

This house has introduced the Japanese decorations upon a light gold ground, which brings out the patterns very prettily.

Several vases decorated in relief in imitation of *cloisonné*. The designs upon these vases are very complicated, and are in imitation of Arabian work. The enamels put on are very thick and stand quite in relief. These goods met with a very large sale during the Exposition.

The colored glass of this house was not up to the usual standard.

JOSEPH INWALD, Palma.

Joseph Inwald.

Two very handsome crystal candelabra, hung with drops, heavily cut in prisms and flutes, and interspersed with handsomely engraved medallions. The metal was of excellent quality, clear and brilliant.

Two large crystal decanters, heavily cut, having large knobs cut out of the metal and engraved upon; these, as well as the candelabra, were fine specimens of the glass-cutter's art.

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JOSEPH AHNE, Steinschönau. AUSTRIA-HUNGARY.

A variety of colored glass, ornamented; black glass with white enamel, opal decorated in gold, etc. Joseph Ahne.

JOS. ED. SCHMID, Annathal. Jos. Ed. Schmid.

The usual variety of colored glass fancy articles. This house also exhibited a style of crystal heavily cut hanging baskets, with handsome cut drops, which were in very good taste and beautiful. Many small bouquet-holders in iridescent glass, blown very thin, had heavy solid feet; the display of the iridescent colors gave these goods quite a pleasing appearance.

FRANZ WAGNER, Meistersdorf. Franz Wagner.

Very handsome square jewelry caskets in black glass, mounted in silvered and gilt frames, decorated in pretty patterns, with white enamels. Caskets and toilet boxes.

A large-size casket was valued at $40. This house seemed to have exhausted ingenuity in making these toilet boxes, as they could be found in all colors and styles of decoration.

A variety of square toilet boxes, having glass drawers fitted in gilt frames, the glass cut, engraved, and decorated in enamel.

A variety of bird cages made of sticks of opal and other colored glasses, the bottoms lined with looking glasses and decorated in enamel. These cages have a remarkably fine appearance.

RUD. GROHMANN & CO., Haida. R. Grohmann & Co.

Among the number of handsome wares of this firm could be seen several very large oil lamps in different colored glasses. Some of the prettiest were of a pale-gray glass, decorated in white enamel in relief; also in black glass, with the same enamels, crowned with very beautifully engraved globes. Fine opal vases decorated in relief gold. A very pretty vase with a dark ruby ground, painted with white raised enamel. A pair of light cream-colored vases, decorated in brown relief enamel.

SCHINDLER & VEIT, Gablonz. Schindler & Veit.

A very fine assortment of imitation precious stones, in all colors; cut beads; paper weights in acid-depolished glass representing cat heads, with mouth and eyes painted in enamel; paper weights with pictures covered over with a varnish.

C. DRESSLER, Gablonz. C. Dressler

Very fine toilet chest of plate-glass, mounted in gold, lined inside with different colored silks. Paper weights of depolished statues, mounted upon bases of colored glass. Also a large variety of imitation stones for jewelry, in very fine colors.

Other exhibits showed artificial flowers made of glass, with a very successful result. These flowers naturally retain their freshness for ever. The china manufacturers, however, are also making these flowers, which look very pretty, and it seems to us that the materials they use are of much easier treatment than glass. Artificial flowers in glass.

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In the Austrian section was one of the attractions of the day, viz, the manufacture of toilet articles and stuffs for ladies' wear, made out of spun glass, by Madame Jules de Brunfaut, Vienna. The glass, shown on the counters in large bundles, to all appearances looks like cotton, and is of a remarkable fineness. This glass is spun into threads like ordinary cotton, and is woven into different colored fabrics, sometimes entirely of glass and sometimes with a chain of silk or cotton.

Spun-glass fabrics.

The novelty of seeing fancy articles made of spun glass attracted the eye of the visitor. Ladies were particularly astonished at seeing collars, neckties, cords and tassels, fringes, pin cushions, little caskets, curled feathers, belts, etc., made of glass. A very handsome ladies' buff-colored bonnet, made of spun glass, with the orthodox feather and ribbons, lined with silk, was the center of attraction. A bonnet of this kind can run the risk of a shower without being spoiled; glass will only look brighter for being washed.

Glass bonnets, and cloaks.

The exhibit included a very handsome cloak, made of knitted wool and lined with glass cloth, the threads being woven a certain distance apart and laid at right angles. This made a very pretty and bright lining, offering a pleasant contrast with the colored knitted wool. The different articles exhibited were made in various-colored glasses. There was quite a variety of colored and white laces; cloths embroidered with glass; very thin woven glass cloth, in which now and then a fine thread of gold-colored glass appeared, making a very handsome fabric. These goods are easily washed by simply dipping in a bath of water and soda, and brushed with an ordinary soft brush.

Hungary.

The Hungarian section had nothing worthy of notice. The glass was of a very poor color, quite yellowish, and the execution of the work quite inferior. Among other things could be seen a very large and heavy vase of crystal, said to have been made 40 years ago, cut poorly, the glass of bad color, and the style very homely.

In conclusion, it may be said that very beautiful glass ware was shown in the Austrian section, and the praise bestowed upon it is well deserved. In this branch of industry, for which Bohemia has been celebrated for many years, are seen the benefits of a continuous manufacturing for a long period of time. Glass making to a Bohemian is as natural as inventing is to a Yankee. Every one is familiar with the art, and, as in other nations, the multiplicity of talent has made

Ancient celebrity of Bohemia.

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AUSTRIA-HUNGARY.

this country particularly celebrated all over the world for its famous productions.

L. Lobmeyr.

L. Lobmeyr, to whom I am indebted for much valuable information on the subject of glass, and who lately published an interesting work entitled, "*Die Glasindustrie: ihre Geschichte, gegenwärtige, Entwickelung, und Statistics*," writes to me that a great part of the good name of the Bohemian glass is due to the fact that the best artists in Vienna are selected for designing the models in the styles in which they are particularly known to excel. It would be impossible for a single artist to create designs suitable for such a variety of shapes and purposes. The government, knowing the importance of its Bohemian industry, has also fostered its development by lending to it the benevolent influence of the Vienna Museum, an institution said to be admirably managed. It is to be hoped that our government may follow in the footsteps of the Austrian, and encourage in our proposed National Museum the dissemination of art, by acquiring specimens of the best-known art glasses and put them on exhibition.

Designs by artists of Vienna.

Government fosters the art of glass making.

Vienna Museum.

Cheapness of Bohemian ware.

One point not to be overlooked in Bohemian glass ware is the cheapness of all their productions. In this they can compete quite successfully with almost any other nation. Austria did not exhibit any window or plate glass, nor were the manufactures of bottles and ordinary green glass represented.

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Société anonyme des verreries réunies.

SOCIÉTÉ ANONYME DES VERRERIES RÉUNIES, Bouseu-les-Mons.

Table, colored, cut, and pressed glass.

The table ware exhibited by this house was of a very ordinary quality, the glass variable in color, and generally of a darkish cast, wanting in brilliancy. The colored glass is also of ordinary quality. The cut glass is irregular in workmanship and polish. A few large pieces were to be seen in crackled ware. The pressed glass, of which there seemed to be a larger quantity exhibited than in the other sections, was of inferior quality in color of metal, and in pressing showing very bad mold-marks and a cloudy surface. A few decorated opal globes were to be seen, but nothing else of interest.

Compagnie anonyme des cristalleries et verreries Namuroises.

THE COMPAGNIE ANONYME DES CRISTALLERIES ET VERRERIES NAMUROISES, Namur.

Table glass, etc.

This manufactory of table ware, gas globes, etc., had a variety of goods on exhibition, but nothing of especial interest could be seen. The irregularity of color in the metal, as well as the want of brilliancy, was also noticeable in their white glass. A few articles of colored glass exhibited were fair, but nothing remarkable. The cut and engraved articles were plain and ordinary. The muslin thin glass was blown with a little more regularity than the other wares. A few opal globes of fair quality. No acid etching was to be seen in the exhibit of the two above-named houses.

Tools.

Tools.

Frankinet & Co.

Spring press.

But few tools for glass-making were exhibited in the Belgian section. The only house, Messrs. Frankinet & Co., of Marchienne-au-Pont, had on exhibition a patented spring press. The springs can be regulated by a screw. The press is so combined that the ring is first brought down upon the mold; then the plunger; and when the latter has reached the bottom the pressure is continued by means of a spring cylinder, which increases the pressure without any shock. In unmolding the operation is reversed, in the order mentioned. The mold slides upon V-ways, and is adjusted in its proper place by means of set screws. Price $150. This press seems to be well combined for giving a gradually increasing pressure without any abrupt movement. The workmanship is good, and is superior to anything seen in the French section. This press much resembles our American presses.

Glass-cutter's frame.

The same firm also exhibited a glass-cutter's frame made en-

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tirely of iron, and permitting to adjust the wheel by means of screws, an improvement over the old wooden frame. BELGIUM.

Several other manufacturers of hollow ware did not think proper to exhibit. Among others, I regretted not to see the Val St. Lambert factories, so celebrated in Belgium and elsewhere for the excellence of their goods. These works are the largest in Belgium, and are to that country what the celebrated Baccarat works are to France. On a former trip to Belgium I saw the glass of this firm in their dépôt in Brussels, and was much pleased with the fine specimens shown. Their style of manufacture approaches that of the English and French, and in some instances is quite equal to some of the best work of these two countries. The St. Lambert works employ about 1,600 workmen, and the annual production is about $600,000. I have had occasion to see M. Jules Deprez, the manager of these works, and in the course of conversation have found him quite disposed to enter into the current improvements daily developed. He stated, among other things, that his works were introducing the Tilghman's sand-blast engraving process. This gentleman also freely acknowledges the superiority of American pressed glass.

Val St. Lambert factory.

Production.

Jules Deprez.

Tilghman's sand-blast.

If Belgian goods in general do not come up to the standard of excellency of some other nations, their remarkably low prices are quite an inducement to the purchaser, and statistics show that two-thirds of her productions are exported. The facilities for glass-making in Belgium are many.

Plate-glass. Plate-glass.

Three only of the plate-glass factories exhibited.

THE MANUFACTURE DE GLACES DE SAINTE MARIE D'OIGNIES is the pioneer works of Belgium. They employ 700 to 800 hands and 600 horses steam-power. Gas furnaces are exclusively used. Manufacture de glaces de Sainte Marie d'Oignies.

The plates sent to Paris were a plain plate, 17.54 feet x 11.25 feet = 197.33 superficies, weighing 990 pounds; a silvered plate, 16.47 x 10.56 feet = 173.92 superficies, weighing 770 pounds. These were the largest in the Belgian section; very clear and free from defects, well pollished, and apparently of a very even surface. Large plates free from defects.

THE SOCIÉTÉ ANONYME DES GLACES ET VERRERIES, DU HAINAUT, at Roux, a new factory, exhibited a plain, a silvered, and a beveled silvered oval plate. The plain plate measured 16.56 x 10.10 feet = 167.25 superficy, weighing 660 pounds; the silvered plate 13.71 x 11.12 feet = 152.45, Manufacture des glaces, etc., du Hainaut.

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BELGIUM.

weighing 616 pounds. Unfortunately the two large plates were broken when the workmen put them up. This house showed the different stages of the manufacture of plate-glass by plates in the rough state, ground, smoothed, and polished. The beveled mirror, although very finely silvered and mounted, had two defects on the edges, showing broken lines on the oval of the bevel. This factory, founded in 1868, is now manufacturing plates of equal quality to any of the older Belgian works. They use a 600 horse-power steam-engine and are provided with the best improved mechanical means of manufacturing. They have two Siemens furnaces, of 12 pots each. The annual production is put down at about 230,000 square feet.

Plate-glass.

Manufacture du Hainaut.

Production.

Soc. anon. de Courcelles.

THE SOCIÉTÉ ANONYME DE COURCELLES exhibited silvered plates of 36.34 inches superficies, weighing 484 pounds, and a plain plate measuring 11.81 x 9.34 feet = 110.31 superficies, weighing 550 pounds. The quality of the glass and the finish are not up to the standard. They also exhibited several samples of rough plate-glass.

This factory was established in 1870; there are now at work 2 Siemens furnaces, with 12 pots each. The annual production is about the same as the Roux factory.

Production.

Other factories in Belgium did not take part in the Exposition—those of Floreffe and Aurelais.

Floreffe factory.

The Floreffe factory has been in operation since 1853. The furnaces used are of the Siemens patent. The annual production is put down at 240,000 superficial meters.

Aurelais factory.

The Aurelais factory is of such recent date that little can be said about it. Its annual production may be estimated at about 90,000 square meters.

The manufacture of plate-glass is extending every year in Belgium. A monopoly, such as is existing in France, is not possible there any longer, as I find several new works have been erected lately.

Lesson for our manufacturers.

Our manufacturers of plate glass, who, for the want of skilled men, have not met with success in their undertaking, should turn their eyes towards Belgium to secure the talent we do not possess as yet. It will also be noticed that the Belgians invariably use gas furnaces in their manufacture. These are undoubtedly the best for such work, and our present and future plate works should adopt them without hesitation.

Use of gas-furnaces.

Grinding and finishing machinery.

The best improved machinery for grinding and finishing plates should also be procured, as much of the success of plate works is due to the proper kind of machinery used.

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Window glass. BELGIUM.

In the manufacture of window glass Belgium is especially far famed, and, though other countries are also making window glass, she is pre-eminently the window-glass manufacturer of Europe. In quality and price she holds a position in the first rank, and although France and Germany are close to her in the race she nevertheless holds her own well. Window glass. Belgium holds the first rank.

The Belgian manufacturers made a collective exhibit of their productions. These were shown in a queerly shaped iron structure, which was intended, doubtless, to show the glass at a good advantage, but it was a signal failure. The structure was built very high, with a spiral stairway in the center to ascend to the upper part, where different colored and etched glasses were mounted. But since the stairway was permanently closed, to see and appreciate the quality of the glass exhibited one ran the risk of dislocating his neck in looking up. Belgian collective exhibit of window glass.

The Belgian window glass in general is of a very good quality, free from air bubbles or impurities, of good color, and the surface very even. The colored glass was of superior quality and of very clear colors; the doubled, trebled, and quadrupled or flashed colored glass was very fine, uniform in the thickness of the coatings, and when etched or engraved presented very fine specimens of workmanship. We regret that some manufacturers had the unfortunate idea of pasting pieces of gold paper on the edge of their glass. Whether this was from intent or carelessness, it is certainly to be discountenanced, as with this paper obstruction the color of the glass in the mass cannot be ascertained. Quality of white, and colored glass.

Among the manufacturers exhibiting were:

F. DEULIN PÈRE, at Jumet, who runs 3 furnaces; 2 with coal, one of a new system with gas, and 3 flattening ovens heated with coal. He employs 160 workmen; the daily production is about 3,000 feet. This house makes it a specialty to manufacture colored glass, but also had white and stained glass on exhibition. F. Deulin Père.

H. J. BIVORT, Jumet, exhibited very large cylinders 129 x 42 inches, panes 81 x 53 inches, 146 x 36½ inches, all made in a very perfect manner; colored, doubled, or flashed glass in very good colors, and engraved in very pretty patterns. M. Bivort was the pioneer in introducing the Siemens furnaces in Belgium for window-glass making. H. J. Bivort.

A. FOURCAULT-FRISON & Co., of Dampremy, exhibited cylinders of 5.08 feet x 3.90 feet, weighing 56 pounds; another 9.12 x 4.37 feet; a sheet 9.57 x 2.88 feet. Fourcault-Frison & Co.

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BELGIUM.

Window glass. Leon Mondron.

LEON MONDRON, of Lodelinsart, also had sheet-glass of large size, one 98 x 32 inches, and another 102 x 39 inches; also a cylinder 115 x 11 inches.

C. Lambert & Sons.

C. LAMBERT & SONS, of Charleroi, had a variety of sheet-glass of good quality, among others one 68 x 38 inches, and a cylinder 7 feet x 9 inches.

Léon Baudoux & Co.

LÉON BAUDOUX & Co., Charleroi. A fine exhibit of colored, engraved, plain, enameled glass; also corrugated glass sheets. An attraction of this exhibit is two corrugated cylinders 7½ feet high, with very straight corrugations.

Verreries de Mariemont.

THE VERRERIES DE MARIEMONT exhibited depolished corrugated and bent sheets. These have been made with a Boëtius furnace, which they introduced in Belgium in 1869, and which by several improvements has been adapted to the making of window glass. The good quality of the glass shown is a proof of the superiority of this style of furnaces, and is also owing to the fact that this firm uses mechanical means for the crushing and mixing of their materials.

Soc. anon. des Verreries du Charleroi.

SOCIÉTÉ ANONYME DES VERRERIES, Charleroi. Window glass in all thicknesses, made in a Siemens furnace. Also depolished glass by the Tilghman process, said to be able to depolish 1,600 square meters of glass in 10 hours.

E. Baudoux.

E. BAUDOUX, of Lodelinsart, had a fine assortment on exhibition of colored and muslin glass, in opal and other very pure colors.

Verreries nationale.

THE VERRERIES NATIONALES, Jumet. Finely engraved sheet-glass, of all colors. The engraving of this house is also made by the Tilghman sand-blast, and is a good specimen of the beautiful work which can be made with this valuable process.

Schmidt, Devillet & Co.

SCHMIDT, DEVILLET, & Co., of Dampremy, exhibited sheets 7.24 x 3.28 feet; and MM. L. Lambert & Co., of Jumet, cylinders of 11.41 x 3.25 feet, and sheets 8.26 x 3.34 feet.

Monnoyer Frères & Co. and other Belgian firms.

Monnoyer Frères & Co., L. de Dorlodot & Co., of Lodelinsart; the Société Anonyme de Jemmapes, V. Brasseur & Co., of Charleroi; Schmidt, of Lodelinsart; the Société Anonyme des Verreries de Marchienne-au-Pont; Alphonse Morel, Lodelinsart, also had a fine assortment of window glass.

Panels and looking-glasses of Aug. Nyssens & Co. and Reverdy & Co.

Before closing this summary description, I must mention the handsomely decorated glass panels and looking-glasses of MM. AUG. NYSSENS & Co. and REVERDY & Co., both of Brussels, the former having silvered mirrors etched in clear and dead surface, the edge beveled, cut, and etched,

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BELGIUM.

all in very good taste. Messrs. Reverdy's handsomely painted plate-glass panels, with frames of colored glass; two blue glass panels, engraved, representing handsome landscapes, and other panels with beautifully tinted ground; handsome looking-glasses, engraved, transparent, and silvered; also a panel mirror in enamel, engraved and silvered, all done in a very artistic manner.

Reverdy & Co.

Glass panels and looking-glasses.

J. B. CAPRONNIER, Schaerbeek, near Brussels. A finely painted subject, representing Saint Roch, presented to the Pope for a church in Antwerp. This gentleman has furnished several churches in Belgium, Italy, England, Germany, France, and the United States. He claims that his colors are perfectly unalterable, and prepares his own enamels.

J. B. Capronnier.

Belgium, in the glass business, as in many other branches of industry, holds one of the foremost posts, especially in the manufacture of objects of utility. By her resources and her frugal population she will continue to remain one of the leading glass manufacturing nations. But her exportations to this country are gradually lessening, and our own manufacturers now supply nearly all the home demand for ordinary goods.

Belgium's foremost position.

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Italy, which of late has been trying to revive the art of making ancient glass, made quite a display at the Exposition. Although I admired several of the productions shown in such profusion, I must say that the impression left upon the mind is one of disappointment. I have seen in the other sections, French, Austrian, and English, much superior wares than even those of the well-known Venice and Murano Company. The colors shown by the Italians, with a few exceptions, are so dull and wanting in the brilliancy of other nations, that the difference becomes painfully apparent on comparison. The wares are blown very badly, and indicate the work of artisans who are not skilled in their art. These defects are especially to be seen in pieces above ordinary sizes. The English and French show much superior goods in that line, and the colors surpass them altogether. I am aware that the aim of the Italians is to reproduce a blending of colors to show soft peculiar tints, but I must confess that they are yet far from success, and a good clear color will always be superior to a dull, undecided, obscured shade. The beauty of glass is its brilliancy, and no attempt should be made to deprive it of this one particular and inherent quality.

Inferior in color to the French, Austrian, and English.

Defects.

Brilliancy the inherent quality of glass.

In regard to taste, I must also say that I have failed to see any great display of it. I cannot see good taste in lusters or chandeliers loaded down with a multitude of glass leaves and flowers of all colors and shapes, thrown together in close promiscuity, without regard to the harmony of colors. Nor can I appreciate mirrors with glass frames loaded down with the same materials.

Overloaded with ornaments.

Although it must be acknowledged that Italian art in mosaics is to be admired, and is superior to anything seen elsewhere, yet the impression left of the Italian section is one that leads me to believe that the ancient Venetian skill has departed from its former center. The Italian mosaics, however, were many of them wonderful productions, both in coloration and execution, and I did not think that so many and such beautiful things could be made out of this art. I must also commend the fancy glass jewelry of this section, as showing with what ingenuity and perfection this material has been treated. The aventurine jewelry and mosaics are really wonderful. This aventurine or imitation gold stone presents many difficulties in its manufacture, but

Mosaics marvelous in color and execution.

Aventurine.

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from the large blocks that were shown, it would seem that they have been thoroughly mastered in Italy. ITALY.

THE VENICE AND MURANO COMPANY had the largest variety on exhibition, and represented probably the best productions of the country. It was established in 1866 by English gentlemen, who, as lovers of ancient art, wish to revive and restore it to its primitive greatness. Venice and Murano Company. Established in 1866.

It would be impossible to describe the objects exhibited without drawings, and a mere description does not convey to the mind any idea of the goods. I will simply describe the styles, without pretending to give the names of the objects they are intended to represent:

A large bowl of white glass, 16 inches in diameter, decorated in gold with different subjects. This decoration is done by covering the glass with gold and scratching out the outlines of the subjects represented. Exhibits of the company.

Another large bowl in pale yellow, decorated in outline painting. The colors in these and other articles of the same kind look rough and as if they had not been half burnt in.

A pair of tall vases of a pale brown glass, blown with longitudinal ribs of opal, put on very straight; the contrast of colors is good. Said to have been sold several times; one pair has also been purchased by the National Lottery.

A vase and bowl of the same colored glasses, but the ribs put on horizontally.

A large variety of marbleized glass vases.

Imitation of precious stones in glass of different colors, presumed to have been made by using sections of different colored glass put side by side.

Small vases showing on the outside irregular threads of colored glass, looking somewhat like crackled ware.

Vases of glass mottled with gold; others with spiral threads of opal.

Decanters in dark marbled glass, running from dark to light marble; a pretty effect.

Blue glass round toilet caskets, with lace pattern in enamel white; execution irregular.

A variety of small vases, with metallic flakes and spun thread; some of white glass with ruby threads; others of colored glasses with threads of different colors.

A vase, opal inner coating, covered over with ruby, making a very pretty color.

A number of articles with filigree work; generally well done.

Vases in millefiori, showing the patterns in sections at the sides.

A vase of white glass, with yellow metallic flakes, having an opal filigree spirally wound around it; rather pretty.

A bowl of white glass, with opal filigree bottom, painted in white enamel; rather inferior.

A large vase of white glass with cover, stem representing a dragon, made of white glass, with inside ruby threads; inferior work. Foot and body of white glass, with opal cross and twisted threads; very pretty and well done.

A candelabrum of white glass, foot tipped with light ruby, stem blown with twisted ruby and vertical straight threads, decorated with swans

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ITALY.

made of opal, glass chains hung in festoon, green scrolls, and flowers, leaves tipped with ruby; height about 4 feet.

Venice and Murano Company.

Tables of mosaics made of aventurine of two shades, blue and green mottled marbled glass, very beautiful in colors and workmanship; the joints of the several pieces hardly perceptible.

A great variety of thin blown articles, badly done, surface full of tool marks and irregular shapes.

A number of cups, made of dark colored marbled glass, which seem to have been cut out of a solid piece; very handsome.

A flower stand of opalescent glass, with a plateau of 20 inches diameter, crowned with a trumpet-shaped vase, decorated with mottled light ruby or rose-colored leaves; the glass full of air bubbles and stones, the shape imperfect.

Several articles made of a light yellow or amber-colored glass of a very good shade. No cut or pressed glass ware to be found in the collection of this house.

A large mirror, with glass silvered frame covered over with leaves, green and white flowers, border engraved, the top of the frame being a piece of silvered glass engraved. A very intricate piece of work, but of poor taste and a bad arrangement of colors.

Venetian glassware.

FIG. 25.—*Venice & Murano Company.*

The designs (Fig. 25) represent some of these wares. The beauty of the contours is, however, frequently spoiled by bad workmanship and defects in the glass.

Chandeliers.

Candelabra.

This firm exhibited quite a large number of chandeliers and candelabra for gas made entirely of glass, covered and decorated with glass flowers and leaves of opal, rose, blue, yellow, and white glass, branches also of different colored glasses; all this work is made of many pieces and is held together by silvered wire. Some of these chan-

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deliers were made of twisted glass branches and flowers tipped with different colored glass.

Venice and Murano Company.

A heavy cross of ruby glass, branches in bronze, with ruby oil-cups. Lamps in the Arabian style.

A cup with two handles, on a foot of white glass, the whole surrounded on the outside with a reticular net work of the same glass in the form of entwined ribbons, completely detached from the body of the cup, but united to it at foot and top.

Mosaics.

Of the mosaic work I cannot undertake to give a description, but its excellence cannot be too highly praised. The articles made by this house are in ordinary white glass—no flint is used. They employ about 210 workmen, including 65 children. The work, as may be imagined, is all done by hand, and the glass is baked in muffle furnaces. The articles are principally reproductions of ancient Greek, Roman, and Egyptian antique glasses in many colors, carved out of blocks; articles imitating Christian glass, with gilding between two layers of glass and mosaics in colored glass, of which they claim to have more than 9,000 shades. The finest work of this firm is the filigree, which seems to be faultless.

Reproduction of antique glasses and wares.

Filigree.

Salviati & Co

SALVIATI & Co., Venice. This house exhibits a great many articles in the same style as the Venice and Murano Company.

Quite a variety of jugs, pots, vases, of marbleized, mottled, and metalized glass.

Articles of different colored filigree.

Ruby-colored vases of a very handsome purplish ruby, with opal threads and border.

The filigree work of this house is finely done and the prices very low.

A flat bowl, 17 inches, of mottled spirals of different colors.

Another bowl, 28 inches, in mottled pink, yellow, and blue, the stem in bluish aventurine, the border in waved scalloped border, in imitation of a shell.

A set of blue bowls in very pretty color, painted in gold enamel.

A vase, 24 inches high, in white glass, with blue and opal waves; badly blown, but pretty in colors.

A pair of vases, blue outside with opal inside; a very pretty color combination.

Vases in gold, mottled, with white-glass handles made of two swans with red bills; the handles poorly executed, the vase pretty.

A variety of mirrors with silvered and engraved glass frames, with top pieces of the same.

In this house, as in the preceding, I saw several samples of beautiful ruby; in fact, such ruby as could not be seen elsewhere.

A vase of green glass, with gold flakes.

Goblets gilded in the bowl up to a certain height, and spiral ruby filigree with opalescent horizontal threads; a handsome combination.

The same gilding as in the preceding house could also be seen in a variety of articles, the designs being shown by denuded outlines.

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ITALY.

The same decorations as heretofore described are also introduced in articles of iridescent glass.

Salviati & Co.

A few goblets blown in molds, with irregular forms. The mold-marks could be detected quite readily.

A large variety of all-glass chandeliers, with the usual unsuccessful and homely combinations; also brackets in the same style.

Small hanging baskets, with glass chains and colored painted bottoms in enamel.

A hanging basket, with perforated metallic frame in which ruby glass had been blown, hung by metallic chains having balls also filled with ruby glass. This is evidently an unsuccessful combination of metal and glass, for I plainly saw a crack in the bottom of the basket. It cannot be expected that glass and metal blown together in this way will stand the different degrees of temperature equally, and expand and contract alike.

Mosaics.

The mosaics of this house, like that of all the other Italian houses, were very beautiful, both in the color of the glass and the thorough execution of the work. I also saw an application of mosaics to a new purpose—book covers of very handsome colored glasses.

I noticed the same shortcoming in this house as elsewhere; the articles are generally badly blown and the glass filled with defects. It would seem as though it had never received a thorough melting.

Davide Bedendo.

DAVIDE BEDENDO, Venice, exhibited the usual decorated mirrors. The display of mosaics of this house is very superior. I saw a very large and handsome table designed in geometrical figures and filled with different imitations of precious stones, the contours of the pieces being cut with a remarkable accuracy.

Mosaics.

Mosaics in relief, and polished

Representations of celebrated buildings and churches in mosaics of excellent colors and execution.

Jewelry.

This house also exhibited a number of articles used for jewelry made of glass, such as necklaces, ear-rings, spun glass, bracelets, neckties, small baskets, etc.

D. T. Olivotti.

D. T. OLIVOTTI, Murano, Venice. A fine display of glass, jewelry, and articles for wear, such as bracelets, ear-rings, table mats, necklaces, etc. These articles are not spun, but consist of threads woven at right angles with different colored glasses. A variety of different colored beads of all shapes and styles, apparently made by twisting glass threads spirally and partially heating them to cement them together. A variety of fancy small toilet bottles made in all styles of colored, marbled, and mottled glasses. Paper weights and fancy goods made in the inimitable aventurine or gold-stone imitation.

Jewelry, beads.

Aventurine.

M. Candiani.

MACEDONIAN CANDIANI, of Venice, exhibited very pretty glass ware made in imitation of marble and precious stones,

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ITALY.

such as the platinized and the so-called Babylonian marbles, agate, lapis-lazuli, onyx, aventurine, Oriental, Japanese, Corinthian marbles in gold and silver; porphyry, etc. He also manufactures all kinds of enamels in very pretty colors. This exhibit was very creditable, and comprised a variety of beautifully mixed colored pastes or glasses.

M. Candiani.

Imitations of marbles and precious stones.

Space will not allow me to describe the pretty fancy goods exhibited by other houses and the numberless and beautiful mosaics to be seen all over the Italian section. In these two particular branches we cannot praise Italian art too much. It will be many years before any other nation will be able to compete with that country in this style of goods. Living is cheap in Italy, and I have been told that an artisan working on mosaics and producing the beautiful designs we saw only gets 50 cents a day, and yet he must be a graduate of the Academy of Fine Arts before he can even earn this pittance. It is really astonishing to see the small and intricate designs of mosaics. This work requires not only a great skill but also a great correctness in the designs. I must also acknowledge that in colored glass several of their colors are very good, but many others are poor, indefinite, lacking in brilliancy, and appear to have been dulled by impure materials or imperfect melting. Neither am I an enthusiast over the reproductions of ancient glass; the generality of them are lacking in taste and regularity of forms.

Other Italian exhibits.

Preëminence in fancy goods.

Mosaics.

SWEDEN AND NORWAY.

SWEDEN AND NORWAY.

These two countries had very little on exhibition.

F. BRESEWITZ, Limmared, Sweden, exhibited some common druggist ware, blue and brown bottles; also several sets of thin blown white glass, painted in enamel colors.

F. Bresewitz.

Norway has two flint-glass factories, one with a Boëtius furnace and the other with a wood gas furnace. These works make all sorts of table ware in flint and half-flint, gas globes, chimneys, etc. One window-glass works uses wood as a fuel in a direct fire furnace; three bottle-works use Siemens gas furnaces, two with pots, the other the continuous compartment furnace.

Flint glass factories of Norway.

The number of workmen in 1875 was:

Workmen in 1875.

In the flint-glass works	291
In the window-glass works	37
In the bottle-glass works	263
Total	591

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SWEDEN AND NORWAY.

Of these 25 are women and 112 children. The annual production is as follows:

Annual production.

Flint glass	$86,500
Window glass	27,000
Bottle glass	86,500
Total	200,000

Bergen glass-works.

At Bergen, Norway, the BERGEN GLASS WORKS are located. They manufacture beer- and wine-bottles and floating glass balls used for fishing. This establishment employs 50 hands, uses a gas furnace, and makes about 1,180,000 pieces yearly.

Vallo glass-works.

The VALLO GLASS WORKS, situated at Vallo, Norway, make wine- and beer-, green and black, bottles and floating balls. These works use coal and peat in a gas furnace The daily production is 7,000 to 8,000 bottles.

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Classification and properties of glass.

Glass is an amorphous substance, hard and liable to break at ordinary temperatures, liquid or plastic at a high temperature, transparent or translucent, white or colored, having a peculiar brilliant and smooth fracture, called "vitreous." It is composed of silica with some of the following bases: potash, soda, lime, magnesia, lead, iron, and alumina.

Kinds of glass:

Several kinds of glass are known, such as window and plate glass, flint, white, and bottle glass, made up in different proportions of sand, soda, potash, lime, red lead, etc.

Bohemian.

Bohemian glass, used in the making of ordinary and fine hollow ware, is a silicate, with potash and lime base. It contains, like all other kinds of glass, a small quantity of alumina from the pots and oxide of iron from the impurities contained in the materials used. Potash is often replaced by soda, owing to the lower cost of the latter.

Bottle.

Bottle glass contains—besides silica—soda or potash, lime, magnesia, alumina, and oxide of iron.

Flint or crystal.

Flint glass, or crystal, is known as a glass with a base of lead and potash. This denomination, however, is not accepted by all nations, as, in Bohemia, lime-glass used for fine table ware is known as crystal. Glass used for optical purposes, with a great density, owing to the lead it contains, is called flint. Strass is another variety of lead glass, used for making imitations of diamonds and precious stones. Enamels contain, besides lead, oxide of tin or arsenious acid.

Lime-glass.

Optical glass.

Strass.

Enamels.

Colored.

Colored glasses are produced by using various metallic oxides, charcoal, or sulphur. Oxide of manganese is introduced to correct the green coloration of glass by giving it a purple tint. In larger proportions it produces various colored glasses.

Characteristics of glass.

Glass at a white heat becomes almost as liquid as water, but when cold is quite rigid; however, at a cherry-red heat it is plastic and malleable. This property of glass enables the blower to work it with facility. At the cherry-red heat it is plastic enough to be blown by means of a pipe and shaped with tools. When it becomes rigid by cooling it may be reheated and worked until the proper shape is obtained.

Rolled.

Glass rolled on a metallic table is made into plates; by blowing it into a mold all kinds of bottles are made. By pressing the plastic mass by means of a press, plunger and metallic mold, glass can be shaped into all kinds of wares, such as tumblers, goblets, vases, etc.

Molded.

Drawn.

By means of the glass-blower's lamp this material can be drawn into very fine

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Classification and properties of glass.

threads and reeled up like ordinary thread. Glass can also be reduced to almost impalpable threads, as fine as filaments of cotton, by means of a steam or air-blast acting upon a very fine stream of molten glass.

Glass as a conductor.

Glass is a bad conductor of heat, and when heated and suddenly cooled flies to pieces. While being worked it cools very rapidly by the action of the ambient air; it becomes necessary to correct this defect by annealing. This operation consists in carrying the glass objects when still hot to a special furnace, where they are reheated to a low cherry-red, and gradually and slowly cooled. This operation, when improperly carried out, exposes the glass to break suddenly. An unpleasant experience of this nature often takes place in households when a lamp chimney, without any apparent cause, suddenly flies to pieces. Under the head of toughened glass we shall again refer to this unfortunate habit. Glass is also a bad conductor of electricity.

Annealing.

Materials of glass:

Materials.

Potash.

Potash.—Bohemian glass is made with carbonate of potash, as pure and as rich as possible. Hydrate of potash of 54 to 56 degrees is the best for use. Potash used in glass making is extracted from the residuum of beet-root sugar making. In Bohemia, a potash extracted from wood ashes, coming from Hungary. America also furnishes a good article. All potash used in glass making should especially be free from soda, as it tends to give glass a green color.

Soda.

Soda.—This alkali, to a great extent, has taken the place of potash. It is used as a carbonate or sulphate. Carbonate is yet used in the manufacture of table ware, but in the making of plate and window glass, bottles, etc., the sulphate is almost entirely used, owing to its cheapness. By adding a small quantity of charcoal to sulphate of soda it is decomposed much more easily.

Lime.

Lime.—In the manufacture of plate, window, and white glass, lime is used as a carbonate or slacked.

Lead.

Oxide of lead.—In the manufacture of flint glass lead is used in the red oxide form, or sometimes as litharge, but the red oxide gives the best results. Red lead furnishes oxygen, which escapes in melting, and serves to refine the glass and burn the organic matters which may be contained in the mixture of materials. Red lead is prepared from the purest of leads coming from England and Spain, which are comparatively free from the oxides of iron, copper, etc. Lead is but little used in this country for glass making,

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with the exception of a few manufacturers who make a superior quality of glass. *Materials of glass.*

Silica.—It is important that sands should be selected with care, as impure silica has the most detrimental effect upon the color of glass. This is especially important in the manufacture of fine table ware, plate, and window glass. All sands should be free from iron, as this is the fruitful source of the green coloration of all glasses. In Bohemia quartz is used instead of sand. It is first heated, then thrown in water; this breaks it into many pieces, which are subsequently reduced to fine powder by mechanical action in wooden mortars with quartz pestles. By this means the introduction of iron is avoided. Silica. Bohemian quartz.

France and Belgium, for the manufacture of fine wares, use the Fontainebleau sand, not far from Paris; also the sands of Nemours, Chantilly, and from the province of Champagne. These sands are used for making flint, plate, and first-quality window glass. French sands.

English sands contain a considerable proportion of iron. Silex is sometimes used instead of sand for fine wares. For plate-glass making sand from the Isle of Wight is used, but for the best qualities of glass the English manufacturer has to import sand from France and this country. Bottle manufacturers, on the contrary, seek sands containing iron and clay, on account of the elements they contain acting as a flux. English sands. Silex.

Silica is found in the shape of quartz, rock-crystal, sandstone, and quartz sand in the crystalline form; in silex or flint stone in the amorphous state. Silica is one of the most abundant natural substances; it is insoluble in water; and resists the action of most chemicals. Among the acids only one, hydrofluoric acid, is capable of decomposing it; this acid decomposes and dissolves glass entirely. Silica, although infusible at the highest temperature of furnaces, has nevertheless been fused by the use of the oxyhydrogen blow-pipe. Silica combines with all bases, alkalies, such as potash, soda, and with metals, lead and bismuth. These give it the property to form vitreous compounds. Lime, magnesia, alumina, form with it infusible compounds; the latter, however, mixed with silicates of potash, soda, or lead, furnishes compounds which are suitable for the work of the glass-blower. It is glass proper. If two infusible silicates are mixed together they nevertheless produce fusible glass. Fine plate-glass has been made with a compound of Forms of silica. Silica: its characteristics and combinations.

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Materials of glass. sand, slacked lime, and carbonate of baryta. This glass, as fine as any ever made, contains, on being analyzed—

Analysis of plate-glass.

Silica	46.5
Baryta	39.2
Lime	14.3
	100.00

Mixture of bases. To produce a glass requiring as little fuel as possible, the glass maker should introduce as many bases as possible in his mixture, such as potash, soda, lime, magnesia, alumina, oxide of iron; these, however, more particularly in bottle glass, where color is not so much an object as cheapness. Per contra, in making pots the clay should be as free as possible from a mixture of bases; simple silicates, such as silica and alumina, are preferable.

American sands. Nature has provided this country with an abundance of sand suitable for glass making. The Pittsburgh hollow-ware manufacturers use a very good quality of sand, procured in Pennsylvania. the Allegheny Mountains, in Mifflin County, Pennsylvania; West Virginia. it is worth about $5 per ton. The West Virginia glass makers use the same, worth about $6.50 per ton at Wheeling. New Jersey glass-houses, and several in Philadelphia, New Jersey. use a sand procured from the State of New Jersey, of very good quality, costing from $2 to $3 per ton. Pittsburgh window-glass works use a cheaper kind of sand, procured from the neighborhood, worth $2.25 to $2.50 per ton. Ohio works use a sand worth from $2.50 to $3.50 per ton. Manufacturers of hollow ware in the Eastern States, and those about New York City and Brooklyn, use a sand procured from Berk- Massachusetts. shire, Mass., worth about $8 a ton; this sand is the purest to be found in the world, and is nearly pure silica; it is found in fine grains and is quite fusible. Western manu- Illinois. Missouri. facturers, in Illinois and Missouri, use sand procured in their respective States, worth from 60 cents to $2 per ton. At Grand Tower, Mo., there is a mine of very pure quality of sand. I know from personal experience that these sands also make a very good quality of glass. Those who are Minnesota. in the proximity of Minnesota use a sand worth $2 per ton, mined in that State from the Saint Croix sandstone, about 50 feet thick, and also at Red Wing, on the bluffs of the Mississippi River. These bluffs are traced all along the river to the southern line of the State. At Minneapolis and Saint Paul a sand rock is also found, furnishing a good quality of sand; this rock in some parts is 175 feet thick.

Indiana. In Indiana sand suitable for glass making is found in abundance near New Providence, where a vein of 16 feet

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thickness exists. This sand is used in the glass works of New Albany, Louisville, Jeffersonville, and Cincinnati; it costs about $3.25 per ton at New Albany, exclusive of royalty. *Materials of glass.* American sands.

In Maryland, in the neighborhood of Cumberland, an excellent quality of sand is found, which, as per analysis of Professor Chandler, of New York, is said to contain 98.25 per cent. of silica, the remainder being sesquioqide of iron, equivalent to 0.29 per cent. metallic iron. This sand is certainly very pure. In the glass works I had in operation in Washington, D. C., a few years ago I made glass repeatedly with this sand, and a better and more brilliant glass could not be made. I found it easy to melt, and containing but very little vegetable impurities. This sand can be had for $2 to $3 per ton. Cumberland has all the materials in abundance in its vicinity for a successful glass manufactory—coal, sand, and clay, all of first quality, besides timber for boxing and packing. The railroad facilities for shipping to different points are good. Maryland.

Virginia has several sand mines of very good quality. In Rockbridge County, on the North River Canal, 25 miles from Lynchburg, is found a very good quality of sand; it has been analyzed by Messrs. Manard and Tieman, of New York, and Prof. John H. Appleton, of Brown University. The assay shows: Virginia.

Silica	97.50
Alumina	1.02
Sesquioxide of iron	1.48

It is found in abundance, and is easy of access. This sand can be delivered at a very reasonable price by the James River and Kanawha Railroad, when it is finished. I have tried a sand sent from Richmond, said to have been obtained in the neighborhood of the city, but found it unsuitable for glass making, owing to the large proportion of mica it contained.

In West Virginia, near Romney, at a place called Hanging Rock, a very good quality of sand has also been found. West Virginia.

In Tennessee, on the line of Tennessee Coal and Railroad Company's road, a short line running to the Suwanee mines, sand of a good quality has been found at several of the cuts on the road. This sand is the result of the disintegration of the sandstone of that locality. This region seems also to be favored for glass making, as coal, sand, and fire clay are found in abundance. Tennessee.

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Crystallization — Devitrification.

Crystallization—devitrification.

When submitted for a long while to a high temperature, glass loses its transparence and becomes opaque, though it may preserve its shape; this is known as devitrification. Reaumur, in 1727, succeeded, by maintaining glass at a very high heat during twelve hours, in producing a hard opaque glass, resembling white porcelain. The attempt has been made repeatedly, but without success, to manufacture this glass as an imitation of porcelain; but the expense of fuel and the difficulty of preserving the shape of articles while under the influence of the long-continued fire has made it difficult and unprofitable. Devitrified glass is harder than ordinary glass and is capable of scratching it readily; it does not break so easily, and cannot be cut any longer by the diamond. It has a noticeable fibrous texture and is a better conductor of electricity. Glass with a potassic base does not devitrify as well as with a sodic base. Bottle and window glass devitrifies easily, and unless the contents of the pots are rapidly worked off the glass is likely to get knotty and lose its transparency; in this state it becomes impossible to work it any longer.

Reaumur.

Devitrified glass.

Resemblance to porcelain.

Characteristics.

Action of air and oxygen on glass.

Action of air and oxygen.—Dry air or oxygen has no effect on glass. Damp air, however, has a marked effect upon glass, owing to the action of the water contained in the air; the fact cannot be attributed to air, since it is only the medium through which water acts.

Action of light on glass.

Action of light.—In connection with this subject it is my pleasant duty to call attention to the numerous and repeated experiments made by Mr. Thomas Gaffield, of Boston, who, as an ex-manufacturer, now an amateur, and a true lover of the art of glass making, has contributed many articles to the literature of glass making. Among others, I may cite a contribution to the Philadelphia Photographer of 1869, entitled "Photographic leaf prints," a discovery made while pursuing his experiments on the coloration of glass by sunlight. In the same periodical Mr. Gaffield, in 1876, published his "Glass for the studio and dark room," pointing out how to select glass properly for the photographic room. In the Boston Transcript of 1876 is a fine review of the absurdity of the "Blue glass mania," and here, also, the unpardonable blunders contained in Wendell Phillips's lecture on the "Lost arts," are handled in a masterly manner. In the same journal, in 1875, Mr. Gaffield wrote a review of the "De la Bastie toughened or tempered glass," about which so much nonsense has been written in our daily journals.

Thos. Gaffield.

Coloration of glass by sunlight.

Photographic glass.

Blue glass mania.

Lost arts (!).

Bastie's toughened glass.

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Action of light on glass.

The writings of Mr. Gaffield bear the imprint of an observing mind, and a fearless denunciation of absurdities wherever found. It is with pleasure that I call attention to the researches of Mr. Gaffield, because of the fact that so far we have had comparatively nothing published in this country in regard to the scientific investigation of glass.

Thos. Gaffield.

Peligot.

Mr. Peligot, in his late work, "*Le Verre*," mentions favorably the researches of Mr. Gaffield. After a series of experiments upon the different kinds and qualities of glass from France, England, Germany, Belgium, and America, Mr. Gaffield has established the following results by exposing to sunlight pieces of glass during different periods of time: The changes in colorless glass after exposure are from white to yellow, from green to yellow-green, from brown-yellow to purple, from green-white to blue-white, and from blue-white to darker blue, according to the length of time of exposure to light. Although colorless glass can be exposed to a furnace heat without changing color, when the same glass has been exposed to sunlight and has acquired the peculiar orange and purple lines, if reheated the original color will reappear. This change, therefore, cannot be attributed to heat. In pot metals of intermediate colors, such as brownish, yellowish, and rose or purple, the change was found to be quite rapid, a few days in some instances being sufficient to show a perceptible change. Mr. Gaffield draws the conclusions from his experiments that the particular shades of colors found in some old cathedral glass are not owing to peculiar mixtures which some writers on glass claim are a "lost art," but must be the result of long exposure to the rays of the sun. This change of color has been attributed to a great extent to the use of manganese, singularly known as a decolorizer among glassmen. Many of the European manufacturers are believers in this theory, and have discontinued its use on that account, or have decreased the proportion used. M. Bontemps mentions that glass containing manganese has been found unfit for light-house lenses. Glass containing lead, however, even in a proportion as small as five per cent., he asserts remains perfectly colorless while exposed to the sun. Peligot believes that to the use of manganese these changes of color may, to a great extent, be attributed; the green tint of ordinary glass being attenuated by the action of sunlight, the peculiar purple color due to manganese becomes predominant.

Changes in glass by sunlight.

Not due to heat.

Colors in old cathedral glass the result of sunlight exposure.

Changes attributed to the use of manganese.

Bontemps.

Effect of use of manganese in lenses.

Action of water on glass.

Action of water.—Water at ordinary temperature and under ordinary contact with glass has but a slight or no per-

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Action of water on glass.

ceptible effect. An increase of temperature and of surface of contact, however, tends to augment the dissolving action of water. The composition of glass has a manifest influence upon its solubility. Where glass contains an excess of alkali it is more apt to be altered by the action of water, while glass containing a predominant earthy silicate is freer from attack. A peculiar purple coloration is often noticed in panes of glass in places exposed to dampness. This is explained by the action of water being in contact with the surface of glass for more or less time, producing a solvent action upon the alkali contained in the glass. If the surface of such a glass is rubbed, small thin pellicles will be detached; they are composed of earthy silicates, the alkaline silicate having disappeared. When the action is continued for a long period the peculiar iridescent coloration increases. According to Newton, this coloration is the result of the reflection of light upon the thin pellicles or pieces which become somewhat separated from the main body of the glass.

Solubility of glass depends upon its composition.

Solvent action on the alkali, producing exfoliation and iridescent coloration.

Haussmann.

The following analysis, made by Mr. Haussmann, shows plainly the action of water upon glass:

Analysis showing solvent action of water.

	Part remaining intact.	Part having been altered.
Silica	59.2	48.8
Alumina	5.6	3.4
Lime	7.0	11.3
Magnesia	1.0	0.8
Oxide of iron	2.5	11.3
Soda	21.7	0.0
Potash	3.0	0.0
Water	0.0	19.3
	100.0	100.0

Absorption of carbonic acid.

All glass when reduced to powder is subject to the influence of water, and gradually absorbs carbonic acid in such a quantity as to show quite an effervescence in contact with acids. Powdered glass boiled in water in contact with carbonic acid absorbs this gas in a few minutes and produces an instantaneous effervescence in acids. Powdered glass kept in boiling water for several hours with sulphate of lime produces a notable quantity of sulphate of soda. All glasses reduced to powder will bring back the blue color of test papers colored red; it is owing to their alteration by the absorption of water. Glass made with soda is subjected to a different alteration from that made with potash. Soda glass continues to become iridescent with time, sometimes to such an extent as to appear to be colored glass, and small pellicles gradually become detached. The same pe-

Tests.

Effect of water on soda-glass.

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culiarity has been noticed in ancient glass dug from the earth, and the iridescent coloration is attributed to decomposition by water. Potash glass is affected by water in producing small crystals upon its surface. This deposit of crystals depolishes glass, renders it rough, and seems to have covered the surface with a multitude of small cracks. These cracks appear to be the result of the small crystals acting upon the surface of the glass in a manner similar to that of cutting with a diamond. Flint and crown glass, for the particular purposes they are intended, are manufactured with a large proportion of alkalies. This excess has the tendency to make them damp on the surface, to make them lose their transparency, and, with time, to alter their shape. Crown-glass disks, piled one upon another, have been known to become cemented quite firmly together; this is caused by the silicate of potash they contain in excessive quantity attracting the dampness of the atmosphere.

Action of water on glass.

On potash glass.

On flint and crown glass.

M. Daubrée, to illustrate the action of water upon glass under pressure and temperature, took some glass tubes and subjected them to a temperature of 572 degrees in contact with water. The result transformed the glass into a fibrous matter resembling Wallastonite (silicate of lime). Thus, it will be seen that manufacturers who may be tempted to produce glass with an excess of alkali, in order to save fuel in melting, are exposed to produce an inferior quality, which, after a comparatively short time, will show the peculiar objectionable iridescent coloration. This coloration, however much prized in fancy articles, is very obnoxious in window and plate glass.

Daubrée.

Transformation of glass into a fibrous silicate

Action of acids and alkalies.

Action of acids and alkalies on glass.

Pulverized glass in contact with hydrochloric acid diluted with hot water, or even at ordinary temperature, is easily attacked. The same effect takes place with lead glass, the dissolution being in contact with hydrosulphuric acid. Bottle glass being made with a large proportion of bases, in order to produce a cheap glass, is very easily attacked by acids. If a bottle is filled with strong sulphuric acid, after a certain time small concretions of sulphate of lime will appear, while alumina and the alkali will be dissolved in the acid. Silica will fall to the bottom in the form of a jelly. Many bottles are attacked by the concentrated mineral acids, but resist the action of these acids diluted. Some bottles are even attacked by the bitartrate contained in wine, and decompose it and impart to it the taste of ink, also destroying its color. It has been ascertained that few bot-

Hydrochloric.

Hydrosulphuric.

Action of the vinous bitartrate of potash.

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Action of acids and alkalies on glass.

tles, if even made of a superior quality of glass, resist the action of wine in course of time. The discoloration of wines is attributed to the formation of a lake made up of gelatinous silica and the coloring matter of wine. Certain

Discoloration of wines by the decomposition of the glass.

white wines will sometimes turn black when exposed to the air even for a few moments. These wines contain tannin, which, under the influence of a small quantity of iron ex-

Action of the tannin of white wines.

tracted from the glass when exposed to the air, form a trace of tannate of peroxide of iron, the coloring matter of ink.

Certain bottles are rapidly attacked by acid liquors.

Discoloration of champagne.

Champagne bottles of apparently good manufacture have been known to alter the color of wine in a few days. Acidulated water, containing only 4 per cent. of sulphuric acid, has also been known to produce even in one day a thick crust of sulphate of lime and a dissolution of sulphate of iron and potash.

Peligot.

Peligot, in making experiments of this nature, found the glass to contain—

Analysis of bottle-glass.

Silica	54.56
Lime	18.20
Alumina	10.43
Protoxide of iron	1.86
Magnesia	0.51
Potash	1.37
Soda	13.07
	100.00

The number of bases contained in this glass explain the rapid effect that even the weakest acids produce upon wine.

Resistance of lead-glass to water and acids.

Flint or lead glass resist much better the action of water and acids. Strong alkaline solutions preserved in lead-glass bottles extract oxide of lead. These alkaline sul-

Effect of alkaline solutions on lead glass.

phates in course of time produce a black deposit. It has been repeatedly noticed how the ground stoppers of bottles containing solutions of caustic soda or potash will with time become thoroughly cemented. This is owing to the formation of a soluble alkaline silicate, which has very strong adhesive qualities. Bottles intended to contain reagents should be made of a hard glass, free from lead. A study of the matters derived from glass by the effect of the solutions used should also be carefully made to avoid erroneous results in making analysis.

Hydrofluoric acid.

Hydrofluoric acid having a very strong dissolving effect upon glass, this quality is availed of for engraving glass and for making easy and reliable analyses of all kinds of glass.

Process of making.

Hydrofluoric acid is made by introducing into a leaden still pulverized fluoride of calcium and concentrated sulphuric

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acid. The mixture is heated and the distillate is received in a leaden receptacle containing water. To manufacture this acid in large quantities a cast-iron still is substituted for lead. The acid is kept in gutta-percha or leaden bottles. It should be handled with great care, for if any of it should penetrate through the skin by an abrasion or a cut it produces painful sores which are difficult to cure. Rubber gloves should be used when it is handled. Process of making hydrofluoric acid.

Analysis of glass. *Analysis of glass.*

As it is frequently important for a manufacturer to ascertain the ingredients making up certain kinds of glass which he may want to reproduce, the following is given by Bontemps as one of the most reliable methods he has found during his long experience as a glass-maker: Bontemps' method.

The glass must first be broken to pieces, then reduced to powder in a steel mortar. Sieve and take away all metallic particles by means of a magnet; further pulverization may be continued in an agate mortar.

Take two grams of the glass powder, put it into a platinum capsule. Take a leaden vase of about 25 centimeters diameter and 6 deep, having a cover of same metal; spread upon the bottom of this vase some pulverized fluoride of calcium; add a sufficient quantity of concentrated sulphuric acid to form a thick batter, which must not rise above two centimeters above the bottom. Place upon this bottom a leaden ring 5 centimeters wide by 0.025 high. Upon this ring place the capsule containing the glass, and add a little water to it; then cover the vase. Warm slightly over a sand bath; the vapor arising will condense into the water contained in the capsule, will attack the vitreous matter, and produce fluoride of silicium, which will volatilize. Stir the matter now and then with a spatula. At the expiration of twelve hours, when the matter has been completely reduced, pour sulphuric acid into the capsule to transform the fluorides of the bases into sulphates. Evaporate to dryness; expel the excess of sulphuric acid by means of heat; then treat the dry mass with water, ammonia, and carbonate of ammonia; boil, filter, and wash in warm water. The residuum may contain sulphate of baryta, carbonates of lead, bismuth, lime, some alumina, and oxide of iron. The filtered liquor contains the alkalies in the state of sulphates, traces of magnesia, and an excess of carbonate of ammonia, mixed with sulphate.

To separate the substances contained in the residuum, treat with dilute hydrochloric acid, which will dissolve all

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Analysis of glass. with the exception of the sulphate of baryta, which may be gathered upon a filter; wash it and burn the filter in a platinum crucible. 116.6 of sulphate corresponds to 76.6 of baryta. The weight of baryta is to be deducted from that of the sulphate of baryta, according to this proportion.

Pass sulphureted hydrogen through the acid filtered liquor; this will precipitate the sulphurets of lead and bismuth; then filter to separate them from the liquor. Burn the filter in a porcelain crucible, sprinkle the matter with nitric acid, containing a little sulphuric acid, to transform the lead into sulphate of lead, which is insoluble. The greater part of the free sulphuric acid is now driven off. The residuum is treated with water and filtered. Sulphate of bismuth is thus separated from the sulphate of lead. According to the weight of the sulphate of lead the quantity of oxide is calculated, 151.5 of sulphate of lead being equal to 111.5 of oxide of lead. Treat the acid sulphate of bismuth with carbonate of ammonia; the carbonate of bismuth thus obtained is calcined, and thereby produces oxide of bismuth, the weight of which is to be determined. The liquor, containing an excess of sulphureted hydrogen, is boiled in order

Bontemps' method. to expel it; add a few drops of nitric acid to oxidize the iron if there should be any; then add caustic ammonia slightly in excess; this will produce alumina and protoxide of iron together. Ascertain the weight of this precipitate after having calcined it; then dissolve it in concentrated hydrochloric acid and add an excess of caustic potash. The iron is precipitated while the alumina is redissolved. Filter, wash with boiling water, and ascertain the weight of the oxide of iron; in subtracting it from the weight of the alumina and oxide of iron hereabove, the difference is the weight of the alumina. The liquor now contains only lime, with traces of magnesia, which may be neglected. Add to it oxalate of ammonia, which will produce insoluble oxalate of lime; filter, wash, and calcine at a high heat capable of transforming the oxalate into a carbonate, then into caustic lime, the weight of which is ascertained.

If zinc is contained in the glass, it will be found in the liquor containing the alkalies, and before dosing these alkalies the zinc should be precipitated by hydrosulphate of ammonia. The sulphuret of zinc is received on a filter, washed with water containing a few drops of hydrosulphate of ammonia; dry and burn the filter in a platinum capsule. Sulphate of zinc is then obtained by a careful roasting. Weigh the zinc.

To dose the alkalies, take the filtered liquor which contains them; evaporate to dryness; heat the residuum, in

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order to get rid of the ammonia salts, which are volatilized. Treat with water and hydrate of baryta, which is added in sufficient quantity to precipitate all the sulphuric acid of the sulphates, and a little magnesia, if there should be any. Filter, to separate the caustic potash and soda which are in solution with the excess of baryta; then add carbonate of ammonia. Carbonate of potash and soda and carbonate of baryta are produced; filter, to separate the latter. Evaporate to dryness, and calcine to expel the excess of carbonate of ammonia. Finally, saturate the residuum with a few drops of hydrochloric acid. Evaporate to dryness, calcine, and weigh the chloride of potassium and of sodium. The chloride of potassium must now be separated from the chloride of sodium. *Analysis of glass.*

Dissolve the two chlorides in a small quantity of water, and pour a concentrated dissolution of perchloride of platinum until the liquor turns a deep yellow. Evaporate the liquor to dryness, and operating with alcohol the double chloride of platinum and sodium is dissolved. There remains the double chloride of potassium and platinum, which is gathered upon a filter. Wash it with alcohol and weigh it after desiccation. 244 of the double salt are equivalent to 74.5 of chloride of potassium. Knowing the weight of chloride of potassium and that of chloride of potassium and sodium united, the weight of the chloride of sodium is deducted. We now calculate the weight of the soda and potash contained in the glass, knowing that 74.5 of chloride of potassium is equivalent to 47 of potash, and that 58.5 of chloride of sodium is equivalent to 31 of soda. Bontemps' method.

All the elements of the glass but silica have now been ascertained. It may be obtained by difference, but it is always best to get it by a direct dosing. To obtain it, mix 2 grams of glass with about 6 grams of dry and pure carbonate of soda; melt in a platinum crucible in a muffle fire. Put the crucible containing the well-melted matter in a large porcelain capsule, with water and hydrochloric acid (use nitric acid when the glass contains lead); the matter is dissolved with effervescence. When the dissolution is complete, take away the platinum crucible, wash it several times, then evaporate all over a sand bath; heat pretty high towards the end. Pour over the evaporated matter hot water acidulated with one of the two acids; leave it to digest and dilute with water. All the metallic oxides are dissolved, and silica only remains as an insoluble residuum. Gather it upon a filter, calcine it after a good washing, and weigh.

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Analysis of glass. To find sulphate of soda, take the liquor from which silica has been removed, and which must contain all the sulphate of soda which is to be found in the glass; add an excess of chloride of barium; boil for a long while, and let it settle for about twelve hours. Receive upon a filter the sulphate of baryta produced, and from its weight deduct the quantity of sulphuric acid, and, consequently, the equivalent quantity of sulphate of soda.

To obtain boracic acid, heat the pulverized matter with carbonate of soda to redness; boil the reddened mass with water. Filter, and by means of carbonate of ammonia the small quantity of alumina and silicic acid which has been dissolved by the alkaline liquor is precipitated. Evaporate to dryness, treat with sulphuric acid, and digest the residuum with alcohol, which dissolves the boracic acid. Saturate the solution with ammonia, redden the residuum which contains the boracic acid, and then ascertain the weight.

To obtain magnesia, use carbonate of soda. Magnesia still remains in solution after having precipitated the lime by means of oxalate of ammonia, since it cannot be precipi-
Bontemps' method. tated by any of the reagents used until now. Concentrate the filtered liquor by evaporation; add phosphate of soda to it. After twenty-four hours all the magnesia is precipitated in the form of ammonia-phosphate of magnesia, which is gathered upon a filter and washed with ammoniated water. 112 parts of this precipitate, calcined, correspond to 40 of magnesia.

The analysis of glass is a very delicate operation, and it is always well to ascertain the right dosing by repeating the operations several times.

Pot-making: Bricks.

Pot making—bricks.

In Europe nearly every manufactory of glass has a pot-maker to make pots, bricks, and the different articles of fire clay used about a furnace. In this country, in manufactur-
Pot-factories. ing centers like Pittsburgh and Philadelphia, factories for the making of pots and crucibles have been established. As every manufacturer, however, is aware of the importance of having good pots, there are but few who are willing to depend upon outside makers to supply them. The breaking of pots always causes serious losses, and unfortunately it is but too often the case that the success of a factory depends upon the skill of the pot-maker. There is no reason for this state of things, and every manufacturer, with a little study and attention, will soon learn how to judge of his clays, and mix them in a proper manner. The building

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of the body of the pot is a work that, with ordinary care, can be taught to an ordinarily intelligent man in a few days. The writer of this, when carrying on glass works in Washington, adopted a mode of making clays which proved quite successful. *Pot-making.*

The clay should be selected from the sievings of different numbers of sieves, commencing from the finest to a certain degree of coarseness. The same method is to be observed for the cement or broken baked clay. In mixing the different selections, in proportions which will readily be indicated by experience, attention should be paid to the fact that too large an admixture of broken cement has the tendency to decrease the strength of pots, and too fine a grained clay exposes the pots to a large shrinkage and a tendency to break. When the clay is thoroughly mixed dry in small quantities at a time, spread it in thin layers, and wet sufficiently. Repeat this operation of mixing in small quantities until you have enough mixed. Cut thin layers across the box, turn them over, and tread with the feet thoroughly. Continue to cut widths and work them in the same manner until you reach the end of the box or trough, when the operation is reversed. The more the clay is worked the better it becomes. This method of mixing clay, observing the proper proportions, has invariably given me satisfaction. The matter of making, drying, and baking pots subsequently, when good materials have been used, mixed, and worked, is comparatively an easy task. To get good pots it is essential to have, 1st, good refractory clay; 2d, to mix sieved clays and cements of different qualities and degrees of fineness; 3d, to properly mix dry, by small quantities, the green clay and cement; 4th, to spread thin layers of the mixture, and wet sufficiently to make the mass plastic, and dampen evenly every particle; 5th, to work the mixture over by small quantities at a time, always interverting the order of layers; 6th, keep the clay well covered to keep it moist, and avoid adding water when once thoroughly mixed.

Sorting the clay.

Cement (broken pots).

Mixing and working.

Requisites for obtaining good pots.

Clay breaking with a clear, smooth, and bright fracture is generally good; the color varies, but the dark gray is generally of a superior quality. When clay remains white after having been submitted to a violent heat, it is generally of a good quality, as the absence of coloration is an evidence of the absence of oxide of iron. Green clay should be unctuous to the touch and adhere to the tongue. A small piece chewed between the teeth will reveal the approximate quantity of sand contained, the silica being readily detected under the teeth.

Indications of quality.

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Pot-making. It is well known that the Chinese allow their clays to ferment or ripen for long periods before they use them, and the longer they are kept the better they claim them to be. Be that as it may, Bontemps, the celebrated glass manufacturer, holds, as the result of his experience, that clays which have been allowed to putrefy make a superior quality of pots.

Ageing; ripening.

Manufacture of pots by pressure. Little or no attempts have been made to manufacture pots by pressure, although it must be self-evident that if we could increase the density of a pot it would add to its homogeneity and consequently to its life. The writer of this, however, some years since, succeeded in making small covered pots, all in one piece, molded and pressed by an improvised press and mold, which, when dry, showed a great hardness and sonority. Tapped all around, they gave the same sound, showing they were quite homogeneous.

Although, as I have said before, pot-making is not a difficult art to acquire, yet, from the number of factories that have had to succumb owing to badly made pots, it is to be hoped that the day is approaching when pots will be discarded entirely, and compartment or tank furnaces will be substituted in their place. The Siemens continuous melting furnace is a notable and worthy step in that direction.

Probable discarding of pots.

Siemens continuous melting furnace.

Fire-bricks. *Fire-bricks.*—More care is devoted to the manufacture of fire-bricks for furnace use in Europe than in this country. The quartz is ground with more care and is freed from iron by sulphuric acid. Sand is sometimes used as a mixture with clay, but with this material it is difficult to make a cohesive brick, while quartz, when properly ground, not in too large grains, presents angular points which facilitate the cementing of the particles. I have often seen in this country bricks made with large—too large—and small pieces in the same brick; this variety of sizes cannot of course make a homogeneous brick, and manufacturers would do well to pay a little more attention to the regularity of the sizes of the ground quartz they use.

Care practiced in Europe.

Welch bricks. In the Welsh district of Great Britain, a very good quality of bricks is made with a mixture of ground quartz or silex, one per cent. of lime, and a sufficient quantity of water. The mixture is introduced into iron molds and is agglomerated by pressure. The lime is used as a flux and cements the quartz. These are excellent fire-bricks and stand a very high degree of heat. An increase of temperature expands instead of contracting them, as ordinary bricks.

Clay is to be found in many places in this country. It

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has been discovered of good quality in several places in Virginia. At Washington, D. C., the writer has tried several qualities of clay found in the neighborhood; his trials prove that there is no necessity for manufacturers to continue to purchase clay from England and Germany, as the results are fully satisfactory. The discovery of clay near Washington has been the cause of developing the clay industry in the neighborhood, and a large drain-pipe factory is now in operation at Potomac City, on the Point of Rocks Railroad. Clay of a very good quality has also been found in Tennessee, on the Tennessee Coal and Railroad Company's road, running from the Nashville and Chattanooga Railroad to the Suwanee coal mines.

Fire-bricks. American clays. Virginia. District of Columbia. Tennessee.

Western glass manufacturers have long supplied themselves with clay obtained from Missouri, near De Soto, costing from $10 upwards per ton. Eastern manufacturers are using English and German clays, at prices varying from $23 to $29 per ton. Missouri clay, when first introduced, did not give much satisfaction until the owners of the mines understood its preparation; it is now equal to any imported clay and is extensively used. Several Western glass manufacturers are also using a clay procured from West Virginia and Ohio. In Clay and Warren Counties, in Indiana, clays, said to be of good quality, are found underlying the seams of coal in the mines. In Maryland, near Cumberland, in the coal fields, are found extensive deposits of fire-clay of very good quality. In this region the "Mount Savage" and the "Savage Mountain" fire-bricks are manufactured. There are also several other works making retorts and fire-bricks of well-known good quality. In the counties adjoining Cumberland, in Pennsylvania, are also found veins of very good-quality fire-clays, some of them measuring 53 feet in thickness. The surrounding country of Cumberland seems to be especially well supplied with glass-making materials.

Missouri. Eastern use of English and German clays. West Virginia. Ohio. Indiana. Maryland. Pennsylvania.

Kentucky seems to be especially rich in fine qualities of fire-clays containing a large proportion of alumina, which has the effect of making articles manufactured with these clays very strong. In Carter County are found clays which on analysis are shown to contain—

Kentucky.

Silica	45 to 64
Alumina	23 to 43
Oxide of iron	A trace
Lime	A trace
Magnesia	A trace
Potash	0.212 to 2.093
Soda	0.283 to 0.728

Analysis of Carter County, Kentucky, clay.

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Fire-bricks.

These clays are highly refractory, and compare very favorably with the clays of Belgium, which are said to be the best in Europe. The analysis of the Belgian clay shows—

Analysis of Belgian fire-brick clay.

Silica	64.2
Alumina	32.2
Oxide of iron	2.4
Lime	0.0
Alkalies	1.2
	100.0

Kentucky fire-brick clay.

In Greenup County, Ky., clays of good quality are also found, but unfortunately they contain larger proportions of lime, alkalies, and especially magnesia; the latter has a tendency to lessen very materially the refractory quality of clay. Other clays, varying in quality, are found in Edmonson, Lincoln, and Madison Counties. Many of the latter clays, though containing impurities, may be made useful by a judicious selection and washings.

New Jersey.

The clays of New Jersey have been tried, especially those from the Amboy district, but so far they have not been used with success for pot making, although they answer very well for the construction of furnaces. Whether these clays, like many others, could not be improved by washing is certainly worth trying. In fact, I believe we have as good clays in this country as we need, and many of the inferior or impure qualities may be prepared as china manufacturers do, so as to render them sultable for pot making.

Sources of European fire-brick clay.

The clays of Europe are principally drawn from Forges-les-Eaux, in France; Andennes, Belgium; Stourbridge, England; Klingenberg, Germany. They average the following proportions:

Silica	64 to 71
Alumina	22 to 38
Oxide of iron	0.2 to 4
Lime	Trace to 1
Alkalies	Trace to 1

Plate-glass.

Plate-glass.

The manufactories of plate-glass are principally located in France, Belgium, England, and Germany.

France.

St. Gobain, and associated works.

In France, St. Gobain, the pioneer and the largest establishment, was founded in 1695, in the castle of that name. Chemical works belonging to this company are erected at Chauny, near St. Gobain. The manufactories of Cirey and Montluçon also belong to this company. There are three other plate works—at Recquignies and Jeumont, owned by

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Plate-glass.

the Belgian Company of Ste. Marie d'Oignies, at Floreffe, and Aniche. Quite recently another factory has been erected at St. Denis, near Paris, for the manufacture of plain and silvered plates, rough plates, etc. MM. J. Grelley & Co. are the proprietors.

French works.

Plate-glass factories of Belgium.

In Belgium there are five plate-glass works, at Sainte Marie d'Oignies, Floreffe, Courcelles, Roux, near Charleroi, and at Aurelais. Each of these works has laboratories attached. Belgium, in 1867, manufactured only 119,000 yards of plate-glass, but at the present day the average has reached an annual production of 357,000 square yards. Three-fourths of the production are exported to the Netherlands, England, and the United States. Prices since 1867 have declined 27 per cent. The exportation, which was then about $350,000, had reached $760,000 in 1877.

Production.

Exportation.

Plate-glass factories of England.

England possesses six or seven plate works. The oldest, St. Helen's, was founded in 1773, and is the first establishment which introduced machinery for grinding and polishing plates. In Germany are to be found the works of Stolberg, near Aix-la-Chapelle, and Waldhof, near Mannheim, founded and owned by the St. Gobain works. These were established to supply the local demand of the country. Three more factories have since been established, one at Walburg, one at Cramplan, and the other at Freden. These, however, so far, are but comparatively small works. The production of Germany is scarcely one-tenth of that of France, Belgium, and England together.

Of Germany.

Of Russia.
Of Bohemia.

Russia has one plate-glass factory at Dorpat. Bohemia has one also at Stockau.

Annual European production. 1860, '67, '77.

Value.

Proportions made by different countries.

In 1860 the annual production of the European manufacturers was 992,000 yards, in 1867 1,100,000, and in 1877 1,800,000 yards, representing a value of about $12,000,000. Out of this amount France makes 600,000 yards, four-fifths of which are made at St. Gobain; England makes 600,000 yards; Belgium, 250,000 yards; the remainder, 350,000 yards, is made in the other countries named. This amount of rough and polished plate-glass, if laid on the ground, would cover about 372 acres. This would make a very respectable hot-house.

Comparative quality.

French and Belgian plates, it cannot be denied, are of a superior quality. English glass generally has a green tint which, although it may not be objectionable for plain window plates, is not as well adapted for silvering. This defect is attributable to the quantity of iron contained in British sand.

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Plate-glass.

Blown plate-glass of Bohemia and Bavaria.

In Bohemia and Bavaria several establishments still manufacture blown plate-glass, but since the articles produced are quite inferior, this industry tends to disappear, and I do not think it worth the while to give any description of the processes used.

English "Patent" glass.

In England a certain kind of plate called patent glass is manufactured. This glass is blown in a similar manner to cylinder window glass, but is flattened with particular care

Process.

to obtain as even and smooth a surface as possible; it is ground and polished somewhat in the same manner as cast plates. This quality is much sought after by photographers, and is also used for window panes and as a cheaper substitute for heavier plates for mirrors, car windows, and in ornamenting furniture.

Composition of plate-glass.

The mixture generally used by manufacturers at the present day does not vary materially from the following:

White sand	100
Sulphate of soda	42
Pulverized charcoal	2.5
Carbonate of lime	20
Arsenic	0.5

Materials.

The quantity of cullets (broken glass) to be added varies according to the quantity a manufacturer has at his disposal. The materials used should be very pure; the sulphate of

Furnaces.

soda should especially be well refined. Of late the old-style direct fire furnace has been replaced by those of Siemens and Boëtius. In the arrangement of a casting house the

Siemens furnace.

Siemens furnace is placed at one end, and the building does not require to be as wide as with other furnaces. These furnaces contain 8, 12, 16, or 24 pots, according to the size; they are rectangular in form. Two rows of bricks support the arches, which are placed far enough apart to permit the passage of the pots. The regenerators are placed immediately below the furnace; the bricks in the passages generally require to be renewed every six months. As these furnaces are now well known, I will not give a particular description of their construction.

Boëtius furnace.

The Boëtius furnace is built above ground, nearly in the same manner as the Siemens. Under the head of "Furnaces" I will describe this furnace more at length.

Annealing ovens.

On the sides of the casting house are ranged the annealing ovens or kilns, and those for heating the pots. The

Casting table, etc.

casting table is placed in the middle, running upon a railway. Alongside is another railway to carry the small running table upon which the plate is pushed when rolled, previously to pushing it into the annealing furnace or kiln.

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Plate-glass.

On the side opposed to this table the crane for raising the pots is placed upon a truck running over a railway. All these railways run the whole length of the casting house.

The operation of casting a plate is as follows:

Operation of casting a plate described.

The glass in the pots having attained the proper degree of liquidity and having received a thorough melting and refining, the fire is slackened to render the mass somewhat viscous by cooling. The doors in front of the pots are lifted or taken away, the workmen, with a long pair of iron pincers, take hold of the pot in the furnace, bring it upon an iron truck or carriage, and at a dog-trot carry it under the crane. The impurities or glass gall upon the surface of the glass are now scraped off, the pot carefully wiped on the outside with a wet cloth to prevent dirt from falling upon the casting table. The pot is now seized by a pair of strong iron tongs or nippers and raised over the table by means of the crane. The casting table is a large cast-iron slab, well polished, mounted upon a carriage running over a railway. Upon this table two iron rules of the thickness of the required plate are now laid on each side. The pot suspended above is now tilted over and the glass poured upon the table. A heavy iron roller is now passed over the glass, the ends of which rest upon the thickness rules. The roller is rolled again back to its original position. During the rolling, if any impurities are detected in the glass when yet plastic, they are removed with suitable instruments. The plate having reached a sufficient degree of solidity by cooling, it is now pushed upon the small running table, and from that transferred to the annealing kiln. The door of the kiln having been closed air-tight, the glass is allowed to remain for about twenty-four hours, when small openings are gradually made until, at the expiration of three or four days, the plate is sufficiently cooled to be taken out without running the risk of breaking it.

Annealing ovens.

The furnaces or kilns for annealing are simply arched furnaces containing one or two fire-places, but of late years but one has been used. In order to hasten the cooling of the kilns the bottom is so made as to reserve passages made of longitudinal walls or clay pipes, covered with the bottom bricks. These passages are open to the cold air and hasten the cooling very rapidly.

Furnaces for leers.

Under the head of "Flattening ovens," in the article on "Window glass," I have described several systems of furnaces which, I think, could be used with advantage and economy, to say nothing of the ease of handling the plates in the annealing ovens. I do not see any reason, either,

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Plate-glass.

why gas should not be used as a fuel in this operation, as well as for the melting of glass. The time required for the heating and the cooling of the plates would be much shorter, and the annealing more uniform on both surfaces. Although many mechanical improvements have been made in working glass, we have remained too conservative altogether in this country in the use of furnaces. I notice of late, however, that several manufacturers of hollow ware are beginning to appreciate the advantages of gas furnaces, and several have already been erected in Pittsburgh, Pa., and elsewhere. It cannot be understood, for instance, why we should not adopt them generally when we are assured of an economy of 40 to 50 per cent. in fuel by the use of the Siemens furnace, and 30 per cent. with the Boëtius system.

Superiority of gas furnaces.

In regard to the grinding, smoothing, and polishing of plates I shall say but little, as it is very difficult to convey a proper description without the use of drawings of the mechanical means employed.

Description of the process of grinding and polishing the cast plates.

The first operation consists of grinding the rough plate having an uneven surface, by means of a large wooden table suspended to the ceiling. This table has its lower face covered over with several blades of cast-iron, screwed to the wooden frame. Immediately under the upper frame is placed another large table, upon which the plate is cemented with plaster. Sand and water are thrown upon the rough plate, the upper table is lowered, and is made to travel back and forth over the surface of the glass plate by means of steam-power. The sand is replaced by emery, gradually increasing in fineness, until the plate, by continued grinding, is sufficiently smooth. Of late years, in Germany and Belgium, a new style of polishing machinery has been adopted. It consists of a large wooden table to which a back-and-forth motion is imparted; also two large iron or wooden frames, to which are secured cast-iron blades. These frames receive a circular translatory motion. This system does double the quantity of work produced by the preceding machine. Another system, an American invention, was put in practical operation at first in England, but is now used in France and Germany. A circular plate of cast iron is screwed upon the upper end of a vertical shaft so as to revolve with it. Above this table frames are arranged to hold the plates of glass, which are laid in a bed of plaster. These frames also revolve on their centers by the friction of the table upon the glass, of course slowly, but so as to present each side of the plate they hold to an

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Plate-glass.

equal amount of rubbing, as they are never nearer to the center of the table or farther from it.

Grinding, smoothing, and polishing the plates.

The same machine is used for polishing, by screwing to the cast-iron table rings covered with felt.

The second operation is the smoothing, and is similar to the preceding, but the rubbing substance is a piece of plate glass instead of iron. This operation is now carried on by machinery to imitate the old hand process.

The glass plate to be smoothed is fastened upon a table, receiving a slow back-and-forth motion. A motion is imparted to the upper platen by means of two levers moving a wooden box, to which is fastened a piece of plate glass, which bears upon the lower plate and is drawn back and forth. As one of the levers acts before the other, the upper plate is moved from right to left and again from left to right, while it is drawn forward and back.

Polishing.

The third operation is the polishing, which is given by means of colcothar or red oxide of iron. The plate is fastened to a table, receiving a back-and-forth motion; a couple of brushes lined with felt, having a motion perpendicular to the table, rub over the surface of the plate and, by means of colcothar as a polishing powder, give it a final polish. It takes from eight to ten hours to polish one side of a plate of five to six superficial yards. Another style of polishing machine is sometimes used, having a translatory circular motion both in the table and the upper polishing platens.

These three operations add considerably to the cost of plate glass; it is, therefore, essential to a manufacturer to have his plates flattened as evenly as possible so as to save in the thickness to be ground away to obtain a perfectly plane surface.

Price of St. Gobain plate-glass, 1862, 1875.

The price of plate glass from St. Gobain was, in 1862 and 1875:

	In 1862.	In 1875.
1 square meter, $1^m \times 1^m$	$9 21	$11 58
2 square meters, $2^m.01 \times 1^m$	20 65	27 00
3 square meters, $2^m \times 1^m.51$	35 90	37 32

These prices show a rise of 30 per cent. in consequence of the additional taxes imposed by the French Government. The price of plate glass rises rapidly with the dimensions.

Price of "third choice" St. Gobain plates.

The following are the prices in France for "third-choice" plates, which are said to be sold in the largest quantities:

	Per square meter.
A plate of 50 square decimeters is worth	$5 12
A plate of 1 square meter is worth	6 40
A plate of 2 square meters is worth	7 45

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Plate-glass.

	Per square meter.
A plate of 3 square meters is worth	$8 48
A plate of 4 square meters is worth	9 00
A plate of 5 square meters is worth	9 52

There are also wide differences in prices according to quality—a plate of 5 meters, for instance, of "second choice" is worth $11 per superficial meter, while the same, "first choice," is worth $12.68.

Silvering.

Silvering.—Silvered plate glass is produced by causing a slight coating of mercury to adhere to the glass. To obtain this result mercury must be retained by a metallic medium; it is, therefore, amalgamated with tin. Mercury, owing to its power of reflecting light very brightly, has been chosen as the best medium.

The operation of silvering is briefly as follows:

Operation of silvering plate-glass by the mercury process.

Upon a very smooth stone table a sheet of very thin tin is spread very carefully, so as to prevent all wrinkles. Upon this sheet mercury is rubbed all over, then as much mercury as the sheet will retain is poured over it. The glass plate is now carefully slipped over the edge of the stone table, as near as possible to the mercury, and lowered on to it. All the parts previous to this operation have been carefully cleaned, and the plate is handled with pieces of tissue paper, to prevent the introduction of dirt. The plate is now covered with a cloth and loaded with weights to expel the surplus mercury. When the plate has been so weighted, the table is slightly inclined, and gradually increasing the inclination from time to time, until the mercury has been sufficiently drained; this generally requires twenty-four hours. The plate is now carefully taken up and carried over to an inclined wooden table, which is depressed gradually more and more to finish draining the mercury until the plate is supposed to be dry.

Process of silvering by metallic silver deposition.

This is the process which has been heretofore followed altogether, but of late plates have been silvered with a solution of silver. Mercury has deplorable effects upon the health of workmen, as they are exposed to its dangerous emanations; these are rapidly absorbed by the skin and produce the well-known and terrible mercurial poisoning. It is hoped, therefore, that mercury will be abandoned, and the new silvering process described below will be adopted in its place. Several methods have been proposed for silver solutions, all springing, however, from the discovery of

Liebig.

Liebig, that aldehyde (produced by a partial oxidation of alcohol) when heated with nitrate of silver, the revivified metal covers the glass with a brilliant metallic coating. It is not my purpose to trace the different improvements made

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Plate-glass. Drayton. Pettitjean.

by Drayton and Pettitjean, but I will briefly indicate the process of the latter, which is now altogether used by the St. Gobain works with perfect success.

Description of the silvering process.

The operation is very similar to silvering with mercury. The table, instead of being a stone, is a hollow sheet-iron table, made quite smooth on its upper surface, and containing inside water capable of being heated by means of steam, to bring the temperature to 95—104 degrees. Preparatory to silvering the glass it should be thoroughly cleaned. The table being ready, a piece of oil-cloth is spread over it, and upon this is laid a piece of cotton cloth. The plates are now put upon these cloths, and the following solutions are poured over them:

Liquor No. 1. Dissolve in a liter of water 100 grams of nitrate of silver; add 62 grams of liquid ammonia of 0.880 density; filter and dilute with sixteen times its volume of water. Then pour in this liquor 7.5 grams of tartaric acid dissolved in about 30 grams of water.

Liquor No. 2. This liquor is precisely the same as the other, with the exception that the quantity of tartaric acid is doubled, say 15 grams.

First pour of liquor No. 1 upon the plates as much as will remain upon the surface without running over. The heat of the table is now increased gradually to 95—104 degrees Fahrenheit, and in about thirty minutes the glass is covered over with a metallic coating. The table is now inclined and the plates washed with water, which carries off the surplus silver. The table is again raised, and liquor No. 2 is now poured over; in about a quarter of an hour another coat is deposited, which covers the glass completely. The plates are again washed; then they are carried to a slightly heated room, where they are gradually dried.

This operation, as will be seen, is quite simple, and is generally performed by women. The silver carried off in washing and that contained in the cloths is recovered again. Since glass silvered by this process is liable to be altered when exposed to the air, and the coating may become easily detached if not covered over with a protecting coat of paint, the silver pellicle is covered with an alcoholic copal varnish, put on with a brush, and when this is dry a coat of red-lead paint is put on.

Silver and mercury processes compared.

Plates silvered by this means have more brilliancy than with mercury, but as there is a slight tinge of yellow given to objects reflected by these mirrors, they were at first objected to. This objection has passed away, however, to a great extent, and the yellow reflection has been obviated by

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Plate-glass. giving a slight coloration to the glass. I have not been able to get positively the relative costs of both processes; it is said, however, that the new silver process costs about 36

Silvering. cents per square meter. Inasmuch as such works as the St. Gobain have adopted it, and as the terrible disorders caused by mercury may be thus avoided, there should be no hesitation in adopting this new process everywhere.

Platinizing. The use of platina has been tried for a reflecting surface, but owing to the somber appearance of reflected objects by looking-glasses prepared with it, it has not met with a commercial success. I do not think, therefore, that it is worth the while to describe the process.

Rolled plate. *Rolled plate.*—England manufactures large quantities of this glass, and lately France and Belgium have taken it up.

Instead of being cast with the costly apparatus necessary for plate glass of large sizes, this glass is cast in a very

Description of process. simple manner. A basin or dipper is introduced into the glass and filled up; this dipper is suspended upon a hook placed in front of the pot, to enable the workmen to dip and withdraw it with facility when it is full. This dipper is carried over an iron table, and by giving a blow upon it all the cooled filaments and pieces attached to the outside fall off. The dipper is now emptied over the casting table, the thickness of the glass being regulated by metallic pieces or rules. The roller is passed over the mass by the workmen, back and forth. These plates are sometimes imprinted with quadrangular ribs, very close to one another, in order to hide the defects or air bubbles which are likely to occur with this mode of dipping glass. These plates are usually cast about one-eighth of an inch thick. They are used for covering hot-houses, for door panels, and for windows.

Plate-glass making in America. Rough plates have already been produced in large quantity in America, but the pioneer establishments in polished and silvered plates have so far been quite unfortunate. There is no reason for this state of affairs. We have materials in abundance, and very cheap. Our labor has decreased in cost so as to put us almost on a par with Europe. Much of the work in a plate-glass manufactory is done mechanically, and therefore does not cost any more than in

Suggestions. Europe. We have the ingenuity to devise and invent our own tools, as is shown by the fact that the polishing machinery now used in Europe is of American origin. Under these circumstances we must, however, come to the reluc-

Causes of failure. tant conclusion that the causes of repeated failures in plate-glass making in this country must be attributed to the want

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of technical knowledge of those engaged in it. In fact, I know personally of the failure of two establishments solely attributable to this cause. This country must and can supply itself with plate glass, and the day is not distant when works properly managed will drive out the imported article. We have been successful in many other branches of glass-making. Window glass is now made very extensively; why not plate glass, which is almost the same industry? A good field is open for success to any one who will embark in this industry, provided he is supplied with the proper technical and practical knowledge.

Plate-glass.

America should make her own plate-glass.

Tempered or toughened glass.

Tempered or toughened glass.

It is not very long since the discovery of M. Alfred de la Bastie filled all our newspapers with paragraphs, more or less ridiculous, about the properties of this glass. Some claimed it was malleable; others that it could not be broken. In fact, tempered glass was called upon to supersede all other materials. The excitement being over, tempered glass may now take its rank among valuable inventions, subject, however, to many defects in its present state.

A. de la Bastie.

The process of tempering glass, as is well known, consists in heating a piece of glass, say a window pane, to such a degree as to approach malleability, but not hot enough to lose its shape; the glass in this state is instantly plunged into a bath composed of fatty and resinous matter, which is heated and maintained liquid at a temperature ranging from 300° to 600°, according to the quality of the glass. The difference of temperature between the malleable state, about 1,400°, and that of the bath constitutes the temper.

Process.

Glass in the plastic state, when plunged into cold water, will fly to pieces if dropped indiscriminately, but if a piece of very fluid glass is allowed to fall into water in the shape of a tear or drop, it will be perceived that the outside of the glass cools at once, while the inside remains partly fluid for some time, as can be distinguished by the red color showing through the water. This cooling will continue until the mass is perfectly solid. This indicates that the outside layer becomes at once condensed by cooling, while the inside remains fluid and consequently more distended. This cooling process goes on, the outside layer compressing the next adjoining, until the whole mass is thoroughly cooled. This peculiar form and state of glass is known as Prince Rupert's drops. Though a hard blow may be struck upon the thick part of these drops, it has no perceptible effect, but if the tail or thin end is ruptured the whole mass in-

Theory of the formation of the "Rupert drops."

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Tempered glass. stantly flies to pieces. The glass appears to be under a great state of tension, and the least rupture of the equilibrium, such as the breaking of the slender thread terminating the drop, is sufficient to destroy the whole mass.

V. de Luynes. M. Victor de Luynes, professor at the "Conservatoire des Arts et Métiers," in Paris, and M. Feil, the celebrated manufacturer of optical glass, have made a series of experiments, establishing the following facts in regard to Rupert's drops: By dipping a glass drop by the thick part into hydrofluoric acid and keeping it in for a certain space of time in order to dissolve it, it has been shown that no explosion takes place, providing the drop does not dip up to the neck. By suspending a drop by the thick part, allowing the end to dip into the acid, it will gradually eat away the thin end without producing an explosion. But if the drop is gradually lowered so as to eat away the parts until it reaches the neck, when this point is attained the remaining parts break, without explosion however, the pieces merely falling into the acid. These two experiments show that the stability of the drop is due to the preservation of the parts making up the neck, and, secondly, that if these parts remain intact successive layers of the drop may be taken away without rupture. The gradual reduction of a drop by hydrofluoric acid shows that as the parts decrease the tendency to explode decreases with the reduction. If a drop is sufficiently large, parts or layers may be removed until but a certain portion remains; the drop may then be broken under shocks, same as ordinary glass. This indicates that the tension force which causes the rupture lies in the outside layers. The cooling of a drop produces several layers of glass, which decrease in temper as they near the middle. The glass under these conditions is in a similar state to a bent plate of glass, the outer side being dilated and the inner side being compressed. Experiments made with Nicoll prisms prove this theory to be correct.

M. Feil on the formation of Rupert's drops.

Until the discovery of tempered glass by M. de la Bastie, it had always been considered that unless a lamp chimney or any other piece of glass was perfectly annealed, differences of temperature brought on suddenly would invariably cause a breakage. The Bastie glass would seem to prove this view to be erroneous, as the tempered glass can sustain sudden and extreme changes of temperature without breaking. I saw at the Exposition a gentleman repeatedly take molten lead and pour it into a glass bowl or tumbler without producing a fracture. A piece of plate-glass tempered by the Bastie process, having been heated among

Experiments with Bastie glass as affecting former theories of annealing.

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coals, was suddenly plunged into cold water without producing any effect. This experiment, repeated five times in succession, did not seem to impair the qualities of the glass, for on dropping it from a fifth-story window it did not break. It may be said, however, that if in the heating the temperature should reach the point at which it would be annealed, the temper would be destroyed. This action does not seem to take place when the period of reheating is not continued too long. A plate of glass 6¼ x 4¼ inches and $\frac{3}{16}$ inch thick could only be broken under the shock of a weight of 7 ounces falling 13 feet, while an ordinary piece of glass of the same dimensions would break under half of that weight falling about 16 inches.

Tempered glass.

Experiments with Bastie glass.

M. Siemens, of Dresden, says that the strength of glass is increased fifty times by being tempered. A bent plate of glass laid upon the floor with the convex side upward is capable of resisting the weight of an ordinary sized man without breaking. The glass while subjected to the weight will flatten out, but as soon as the pressure is removed it will spring back at once to its original shape. Hardened glass seems to be less dense than ordinary glass; it is harder, however, and is more difficult to cut by the diamond and tempered tools; it also possesses a much superior elasticity over the ordinary glass. These properties of tempered glass have a striking analogy with those of tempered steel.

Siemens.

Analogy of the results of glass and steel tempering.

Since tempered glass, however, cannot be cut with the diamond without flying to pieces, its use must necessarily be limited to definite sizes not requiring to be modified; this is quite a drawback to its use. It would seem, however, that some of the defects have already been overcome, for I saw in the Exposition quite a display of tempered glass made by the *Société Anonyme du Verre Trempé*, of Paris. Among other things was quite a display of druggist and chemical glass ware, mortars, pestles, beakers, covered bowls, funnels; also a variety of plain and cut glass tumblers, goblets, decanters, globes, and chimneys; opal plates; a depolished bowl with cut facets; colored glass, engraved, cut, etc. I have been assured, however, that the making of many articles varying in thickness is rather hazardous, as many of them, such as decanters, are apt to fly to pieces either in the making or cutting. It seems, from what I have described of the theory of tempered glass, to be an unwise attempt to manufacture it into cut or engraved glass ware. If tempered glass owes its toughness to the tempering of the outside layers, and the toughness diminishes as we reach towards the center, why seek

Limitations of the use of tempered glass.

Exhibit of the *Société Anon. du Verre Trempé.*

Chemical, table, and engraved articles.

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Tempered glass. to destroy this quality by taking away the additional strength in grinding, engraving, or cutting? It is my opinion that although tempered glass may at the present time be applied with a great advantage to many purposes, it is not yet perfect enough to manufacture cut glass ware.

Doubtful applicability of the process to cut glass ware.

The Bastie system of tempering glass is carried on in this country by Messrs. E. de la Chapelle & Co., at their works at South Brooklyn, N. Y. I saw it in operation, but applied, however, in a somewhat different manner. Plates and cups made of opal glass are tempered directly after having been pressed in a mold, being, however, previously reheated in an oven. This mode of manufacture seems to be very crude, and under such conditions it would probably be difficult to obtain a uniform temper. The manager of the works was kind enough to show me through every branch, and repeatedly demonstrated to me how readily tempered glass could resist heavy shocks; plates, cups, and saucers were thrown across the room and upon the floor with great violence without breaking them. Several piles of plates were also handled by him, and plate upon plate being piled up in the most approved style of our restaurant dish-washers, stood the test thoroughly, with the exception of a few. Those breaking under the same trial as the others confirmed us in the opinion that it was owing to an irregularity of reheating, and therefore of temper, that they did not stand the test. The primitive appliances used in this factory cannot secure a very regular temper.

E. de la Chapelle & Co.

Process employed.

Tests of the ware.

Compressed glass.

Compressed glass.

M. Siemens, of Dresden, having become convinced that tempered glass by the Bastie process could not be manufactured currently, has sought to avoid its defects by other means. He also attributes the tendency of tempered glass to explode to an excessive tempering. Instead of using an oleaginous bath, he casts his tempered glass in cooled metallic molds; by this means he claims to make a superior quality of glass to the Bastie, and that he is also enabled to make larger and more regular panes of glass. This glass, however, like the Bastie, cannot be cut with a diamond; the sheets must therefore be made of given sizes. After repeated trials during one year, the manufacture of this glass is now carried on regularly at the Siemens works. It is claimed that the resistance of this glass to blows is greater than that tempered in oil in the proportions of 5 to 3. The fracture is fibrous and the glass may be bored and polished; its cost, however, is said to exceed the glass tem-

Siemens process.

Character of the ware.

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pered in oil. Compared to ordinary glass this compressed glass is said to be eight to ten times stronger. *Compressed glass.*

I hope this question of tempered glass may be investigated by some of our manufacturers, as I believe that, with a proper adjustment of tempering, glass may be made to acquire a much greater strength and resistance to extremes of temperature. With the well-known ingenuity of our glass manufacturers, I hope to see the day when obstacles incidental to tempered glass will be removed. Prospects of overcoming all difficulties in the process.

Soluble glass. *Soluble glass.*

Although the manufacture of soluble glass does not strictly belong to the glass-maker's art, yet it is an allied process to that of manufacturing glass. Of late soluble glass has been used with good effect as a preservative coating for stones, a fire-proofing solution for wood and textile fabrics. Very thin gauze dipped in a solution of silicate of potash diluted with water, and dried, burns without flame, blackens, and carbonizes as if it were heated in a retort without contact of air. As a fire-proofing material it would be excellent were it not that the alkaline reaction of this glass very often changes the coloring matters of paintings and textile fabrics. Since soluble glass always remains somewhat deliquescent, even though the fabrics may have been thoroughly dried, the moisture of the atmosphere is attracted and the goods remain damp. This is the reason why its use has been abandoned for preserving theater decorations and wearing apparel. Another application of soluble glass has been made by surgeons for forming a protecting coat of silicate around broken limbs as a substitute for plaster, starch, or dextrine. Uses. Fire-proofing. Splints and bandages.

The only use where soluble glass has met with success is in the preservation of porous stones, building materials, paintings in distemper, and painting on glass. Before I describe these applications I will give the processes used in making soluble glass. Preservation of masonry and walls.

The following ingredients are heated in a reverberatory furnace until fusion becomes quieted: 1,260 pounds white sand, 660 pounds potash of 78°. This will produce 1,690 pounds of transparent homogeneous glass, with a slight tinge of amber. This glass is but little soluble even in hot water. To dissolve it the broken fragments are introduced into an iron digester charged with a sufficient quantity of water, at a high pressure, to make a solution marking 33° to 35° Baumé. Distilled or rain water should be used, as the calcareous salts contained in ordinary water would Process of making soluble glass.

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Soluble glass.

produce insoluble salts of silicate of lime, which would render the solution turbid and opalescent; this solution contains silica and potash combined together in the proportion of 70 to 30.

Silicate of soda is made with 180 parts of sand, 100 parts carbonate of soda (.91), and is to be melted in the same manner as indicated previously.

Process of making soluble glass.

Soluble glass may also be prepared by the following method: A mixture of sand with a solution of caustic potash or soda is introduced into an iron boiler, under 5 or 6 atmospheres of pressure, and heated for a few hours. The iron boiler contains an agitator, which is occasionally operated during the melting. The liquid is allowed to cool until it reaches 212°, and is drawn out after it has been allowed to clear by settling; it is then concentrated until it reaches a density of 1.25, or it may be evaporated to dryness in an iron kettle. The metal is not affected by alkaline liquors.

Characteristics of soluble glass.

This glass is soluble in boiling water; cold water dissolves but little of it. The solution is decomposed by all acids, even by carbonic acid. Soluble glass is apparently coagulated by the addition of an alkaline salt; mixed with powdered matters upon which alkalies have no effect it becomes sticky and agglutinative, a sort of mineral glue.

Mode of application to buildings.

To apply soluble glass for the preservation of buildings and monuments of porous materials, take a solution of silicate of potash of 35° Baumé, dilute it with twice its weight of water, paint with a brush or inject with a pump; give several coats. Experience has shown that three coats applied on three successive days are sufficient to preserve the materials indefinitely, at a cost of about 15 cents per square yard. When applied upon old materials, it is necessary to wash them thoroughly with water. The degree of concentration of the solutions to be used varies with the materials. For hard stones, such as sand and free stones, rock, etc., the solution should mark 7° to 9° Baumé; for soft stones with coarse grit, 5° to 7°; for calcareous stones of soft texture, 6° to 7°. The last coating should always be applied with a more dilute solution of 3° to 4° only.

Opinion as to the permanent value.

Authorities are divided upon the successful results of the preservation of stone by silicates. Some claim in the affirmative, that the protection is permanent, while others assert that with time and the humidity of the atmosphere the beneficial effects gradually disappear. It might be worth while to experiment upon some of the porous sandstones which, under the extreme influences of our climate, rapidly deteriorate. Such, for instance, as the Connecticut sandstone,

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so popular at one time as a building material, but which is now generally discarded, owing to its tendency to crumble to pieces when exposed to the weather even for a few years. *Soluble glass.*

Soluble glass has also been used in Germany to a great extent for mural painting, known as stereochromy. The process consists in first laying a ground with a lime mortar; when this is thoroughly dry, it is soaked with a solution of silicate of soda. When this has completely solidified, the upper coating is applied to the thickness of about $\frac{1}{16}$ of an inch, and should be put on very evenly. It is then rubbed with fine sandstone to roughen the surface. When thoroughly dry, the colors are applied with water; the wall is also frequently sprinkled with water. The colors are now set by using a mixture of silicate of potash completely saturated with silica, with a basic silicate of soda (a flint liquor with soda base, obtained by melting 2 parts sand with 3 parts of carbonate of soda). As the colors applied do not stand the action of the brush, the soluble glass is projected against the wall by means of a spray. After a few days the wall should be washed with alcohol to remove the dust and alkali liberated. Use in stereochromy.

The colors used for this style of painting are zinc white, green oxide of chrome, cobalt green, chromate of lead, colcothar, ochers, and ultramarine. Colors used in stereochromy.

Soluble glass has also been used in the manufacture of soaps made with palm and cocoa-nut oil; this body renders them more alkaline and harder. Use of soluble glass in soap.

Interesting experiments have been made with soluble glass for coloring corals and shells. By plunging silicated shells into hot solutions of salts of chrome, nickel, cobalt, or copper, beautiful dyes in yellow, green, and blue are produced. Here seems to be a field for farther applications of this discovery. Use in coloring corals and shells.

Soluble glass has also been applied to painting on glass in imitation of glass staining. By using sulphate of baryta, ultramarine, oxide of chrome, etc., mixed with silicate of potash, fast colors are obtained similar to the semi-transparent colors of painted windows. By this means a variety of cheap painted glass may be made. Should these colors be fired in a furnace, enameled surfaces would be produced. Use in painting on glass.

As a substitute for albumen for fixing colors in calico printing, soluble glass has been used with a certain degree of success; also as a sizing for threads previous to weaving textile fabrics. Thus it would seem that this substance has been used for many purposes, but since its application does not seem to have been extended to any great degree, the Use a substitute for albumen in calico printing. As a sizing.

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Soluble glass. defects I have pointed out in its use as a fire-proofing material perhaps also exist, to a certain degree, in its other applications. In painting upon glass, for instance, it is asserted that the brilliancy and finish of ordinary vitrified colors cannot be obtained.

Window glass.

Window glass.

Although window glass, at the present time, is universally used, it is but a few hundred years since it has come into general use. Although doubt has existed as to whether window glass was used by certain ancient peoples, it is now an established fact that glass windows were known, if not to the Greeks, at least to the Romans, before the Christian era. The discoveries made at Pompeii and Herculaneum of windows set with glass have removed all doubt upon the antiquity of the use of this material for transmitting light.

Ancient use: Pompeii, etc.

Bontemps.

M. Bontemps examined some of the window frames found at Pompeii, and he gives it as his opinion that the panes, instead of having been blown, must have been cast in metallic frames, probably of bronze. These panes show very irregular thickness; a conclusive evidence that the glass could not have been blown. Thus, sixteen centuries before casting plate-glass, as by the present method, the Romans were using a process very similar in its nature. The Pompeiian glass, upon analysis, shows the following ingredients:

Pompeiian cast glass window-panes.

Analysis of Pompeiian glass.

Silica	69.43
Lime	7.24
Soda	17.31
Alumina	3.55
Oxide of iron	1.15
Oxide of manganese	0.39
Oxide of copper	Trace

It would seem that the use of glass for windows at Pompeii was not extended to a great degree, for but few specimens have been found.

The use of glass for windows of dwellings was first introduced in the fourteenth century. They were first made of small pieces of glass leaden cames. The use of glass incased in wooden frames was first introduced under the reign of Louis XIV of France; the pieces of glass were very small. In England it was only during the twelfth century that glass panes were introduced. Two centuries ago glass windows were very rare. In 1661, in Scotland, windows were only to be found in the principal chambers of the king's palaces. Le Vieil says that towards the end of the twelfth century Englishmen did not know what a glass-house or a window was. Workmen at that time were brought from

Panes in leaden cames.

Progressive use in France and Britain.

Le Vieil.

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France to make windows, and brought the glass with them. Windows were then described as "new things" in that country, "necessary against rain and birds." *Window glass.*

It is not our purpose to trace the history of window glass, but it would seem that, according to the best documentary evidence, before the fourteenth century but little if any white glass was used for windows.

Glass in tenth and twelfth centuries:

According to M. Le Vieil, painting on glass was discovered in the twelfth century. The first windows are said by him to have been painted for the St. Denis Abbey. This, however, appears to be an erroneous statement, for several monuments had been decorated with painted windows before this. Among others the Abbey of Leroux, in Anjou, France, dating from 1121; in Bavaria, in the Abbey of Tegernsee, where window frames are preserved dating from the tenth century. Glass painting, with vitrifiable colors, according to several authors, was discovered about the tenth century.

Abbaye St. Denis.

Anjou and Bavaria.

English still make crown glass.

In Europe window glass is made in two ways, crown and cylinder glass. Crown-glass making is almost abandoned, with the exception of a few factories in England; it is an awkward and unprofitable way of manufacturing, and is not, I believe, practiced anywhere in this country. Cylinder-blowing being more economical and producing a better quality of glass, this method has been adopted all over the world. The Venetians and Bohemians blew cylinders for the windows of the twelfth and thirteenth centuries. Cylinder-blowing was introduced in France from Bohemia in the beginning of the eighteenth century.

Abandoned elsewhere.

Cylinder-blowing originated in Venice and Bohemia.

French production of window glass.

France now manufactures a large quantity of window glass, one factory alone, "*La Compagnie des Verreries de la Loire et du Rhône*," producing annually 590,000 square yards, and 89,000 yards of colored glass. In the north of France 25 to 30 furnaces of 8 pots produce from 4,500,000 to 5,000,000 square yards. The annual production, according to the official statistics of 1873, is put down at $4,400,000; for 1878, $3,000,000. In France, as in other countries, glass manufactories are to be found mostly near the coal fields.

Belgian production of window glass.

Belgium has 60 window-glass factories, with 213 furnaces, containing each from 6 to 8 pots. These factories are mostly located near Charleroi and Jumet; a few, however, are to be found near Mons. Owing to the general commercial depression now existing, about one-third of these factories are idle. The annual production, notwithstanding this reduction, has fallen off but little, owing to gradual improvements which have been introduced in the methods of working and

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Window glass. in the construction of furnaces. These improvements have increased the production from 20 to 25 per cent., with the same running expenses of a few years ago.

Belgian production. The annual production in 1877 may be put down approximately from 175,000,000 to 185,000,000 pounds, say 18,000,000 or 19,000,000 square yards. Nine-tenths of this production are exported. The highest figures in the exports were, in 1874, 177,400,000 pounds; in 1875 the figures fell to 164,250,000 pounds; in 1877 the exportation still reached 163,000,000 pounds. These figures speak highly in favor of the low prices and the good quality of Belgian glass, and are an acknowledgment of the great resources of that country for glass making. Would that this country, with her equally wonderful resources, could make as good a showing.

Analysis of French window glass. The following is given as the average composition of French window glass:

	Parts.
White sand	100
Sulphate of soda	35 to 40
Lime	25 to 35
Powdered coal (usually coke)	1.5 to 2.0
Bioxide of manganese	0.5
Cullets in variable quantity, but usually the same quantity as the sand.	

Use of arsenic. Arsenic is sometimes added in order to refine the glass; this substance does not remain in the glass, but is vaporized and passes through the mass in the shape of gas, stirring the metal and thereby refining the glass. It is preferable, however, not to use arsenic, but to use finely pulverized and sifted materials. In Bohemia a substitute is used for arsenic; it is simply a potato put at the end of an iron bar and plunged into the mass. A green stick of wood also answers the same purpose, both producing watery vapor which escapes through the metal.

Discoloration of glass by impurities. Most glasses have a greenish tinge, owing, it is thought, to the use of sand more or less ferruginous. Glass made with potash is freer from this coloration, but owing to the higher price of potash and the hardness, and difficulty in working, this glass it is now but little made. The green coloration is usually corrected by a small quantity of bioxide of manganese. This body should be as pure as possible,

Manganese as a corrective. since it is a strong coloring element, turning glass to rose color, purple, and even black, according to the quantity used; consequently, it is always used in very small proportions as a corrective. I have also shown that the use of manganese should be dispensed with whenever it is possible, as glass containing it while under the action of sunlight in course of time acquires a purple tint.

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Window glass.

In France and Belgium pots usually contain from 1,000 to 1,200 pounds of glass. In England they are much larger, holding as much as 5,000 pounds. Furnaces usually hold 8 pots. It is customary in some factories to make pots very thin and replace them regularly at the end of the week, instead of making them of a great thickness to prolong their life. This system has advantages. A thin pot will allow the heat to penetrate the mass of the metal much more readily than one with thick sides. It is also very frequently the case that when broken pots are removed from the furnace, and the hands are at work, the rush of cold air is very apt to break other pots. This regular change of pots is of course only applicable in factories where melting and blowing is completed every twenty-four hours. The batch is put into the pots in three different times—seven hours being allowed for melting the first charge, four hours for the second, and three hours for the third. The mode of working is similar to that followed in this country, with the exception that many manufacturers work the glass in the melting furnace instead of blowing from an additional furnace, as is the custom in England and in some places in this country. The question of an additional furnace with French and Belgian manufactures is one of fuel, but where coal is in abundance it is obviously a plan so superior to use a separate blowing furnace that I am surprised it is not more generally adopted. One blowing furnace may be used for two melting furnaces, and by using it continuously the extra expense of fuel is not proportionately so great as when the work is intermittent. It is also obvious that work can be performed in a less crowded state of the workmen; the melting furnace can be regulated much better for the different degrees of heat required; the metal may be emptied at once from each pot in succession; in a word, as Bontemps expresses it, "Every manufacturer who does not adopt this system will be obliged to cease making window glass." A workman usually blows during 20 hours, and averages from 16 to 17 cylinders per hour, making sheets of 22 x 26 inches.

Systems of furnaces and pots in France, Belgium, and England.

Change of pots.

Melting and working.

Melting furnaces and blowing furnaces.

Saving by use of separate blowing furnace.

Workmen's shifts.

I shall not describe here the tools used for blowing window glass; I found nothing new. The same tools used for years are still to this day in existence. Nor shall I describe the method followed in blowing cylinders, as it is practically the same as in this country. In Belgium, in some factories, the handling of glass is rendered lighter by the use of a small truck running upon rails; upon this truck the blow-pipe is rested, relieving the workman from the

Tools, etc., used in blowing window glass.

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Window glass. weight of the glass. In Bohemia, where looking-glasses of large sizes are blown, the workmen use levers, cranes, props, and other mechanical means. Some manufacturers in Bel-

Splitting cylinders. gium split the cylinders with the diamond. A long wooden rule is laid lengthwise inside of the cylinder, a diamond fastened at the end of a long stick is made to travel forward while held against the rule, thereby causing the cylinder to be split in the middle longitudinally.

Flattening ovens. *Flattening ovens.*

Compartment ovens. In Europe the usual style of compartment ovens, with flattening, cooling, and piling-up sections, is still somewhat used. The flattening stone, as usual, is carried by a small truck running on rails. An improvement in flatten-

Segard's oven. ing ovens has been made by M. Segard, of Anzin, France, by which the quantity of glass flattened has been increased, 600 cylinders being flattened in 24 hours. The system

Use and application. consists of two stones carried on carriages running on rails arranged on different levels, so as to enable one carriage to pass under the other. The glass is first flattened upon one of the stones, then pushed into the cooling oven; the next stone is now used for a second cylinder, and the first stone is returned to its original position by passing under the other one. The operation is repeated for every sheet flattened. This system, although economical, is subject to the breaking of the stones when the carriages are raised to pass over one another.

Description of another style of flattening oven. In another style of flattening ovens the cylinders are introduced into a compartment where they are heated, then flattened upon a stone carriage; the carriage is then pushed into another compartment at the head of the leer, and from thence the sheet is pushed upon iron bars countersunk in the masonry of the leer floor and laid lengthwise; these bars are connected together at both ends, and slide upon rollers laid in the countersunk masonry. Through a system of balanced levers the bars can be raised out of the gutters where they are kept below the surface of the floor, and in so doing the sheets of glass are raised from contact with the floor. While in this position the bars are pulled forward a sufficient distance to make room for a new sheet. This operation, being repeated as often as necessary, finally brings the sheets to the end of the leer, after having been gradually cooled in a better manner and more rapidly than by the usual method. It will be observed that after each sheet has been brought forward the bars are lowered on the rollers and returned to their original position. This oven

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contains only nine sheets, which reach the end of the leer in twenty or thirty minutes, instead of seven or eight hours with the old system. Glass annealed in these furnaces can be cut more readily and seems to have been cooled more uniformly on both sides, owing to the periodical lifting of the sheets, and the risk of breakage in cooling is considerably decreased. These ovens, moreover, cost much less and are smaller than the old-style ones; they also show a notable saving of fuel. *Flattening oven.* Good annealing results.

The well-known furnace with rotating stone and compartments in connection with a leer are also used successfully.

Another description of flattening oven has also been introduced in France of late, but it is principally used for baking colors on enameled glass. It has been recommended, however, for window glass. This oven is built in the shape of a leer, with compartments attached for heating and flattening the cylinders. The flattening compartments contain the usual flattening stone mounted upon a carriage traveling back and forth upon rails from the heating to the flattening chamber. The leer contains a number of rollers mounted on shafts placed diagonally across and near enough to one another to give a sufficient resting support for the sheets of glass. These rollers, by suitable gearing, receive a slow rotary motion. The operation is as follows: The cylinder is introduced into the heating chamber, then placed upon the stone when properly heated. The sheet is now flattened and the stone-lined carriage pushed into the next chamber opposite the mouth of the leer. The workman, by means of a suitable tool, places the sheet upon the first of the series of rollers; the rotary motion imparted to them gradually and slowly carries the sheets to the end of the leer, where they are withdrawn. It will be seen that the action of the oven is continuous, simple, and possesses, besides the advantage like the preceding one described, of allowing both sides of the sheet to be equally cooled. Whether the large number of rollers required to traverse the whole length of the leer may not be a source of trouble to keep them in order experience alone can determine. French oven for baking colors on enameled glass. Description of the leer. Operation.

Since sheets of glass, however well flattened and annealed they may be, have a tendency to show iridescent colors, it is customary to plunge them, as they come from the leer, into water containing a small quantity—about two per cent.—of hydrochloric acid. After this washing and drying, the glass becomes less subject to the action of the air. Treatment to remove tendency to become iridescent.

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Fluted glass.

Fluted glass.

Use.

A great deal of this glass is used in Europe. Owing to the semi-circular flutings pressed upon it, the interior of apartments fitted with this glass cannot be seen, but yet allows a free transmission of light; it is therefore much used for door panels and window panes. This glass is prepared by blowing a pear-shaped piece, which is then introduced into a brass mold having a number of deeply-chan neled flutings inside. It is now blown and receives the imprints of the flutings, and the cylinder is finished as usual, being careful, however, to impart no rotary motion to the blowpipe, as by so doing it would distort the flutings. The expansion and lengthening of the cylinder reduces the depth of the flutes, but the mold is so calculated as to leave sufficiently deep indentations after the cylinder is finished.

Mode of making.

Enameled glass.

Enameled glass.

This branch of the glass-maker's art is carried to a great state of perfection on the Continent of Europe, and fusible colors are made by several celebrated manufacturers. It is not my purpose to enter upon a minute description of its manufacture, but I believe the superiority of the work turned out by the European manufacturers is due to the excellent quality of fusible colors and enamels manufactured for the trade. The means employed for applying the colors and the baking are simple and well known. I regret to say, however, that so far we are nearly entirely indebted to Europe for our fine colored enameled glass, as our manufacturers have not yet produced anything but the plain gray enamel with success.

Causes of the superiority of European work.

Colored sheet-glass.

Colored sheet-glass.

The most beautiful colored sheet-glass is made by the French and Belgian manufacturers, such as sheets composed of two layers or coats of glass, white and colored, and in some instances sheets made of white glass and covered over with as many as four different layers of colored glass, put on very thin and equal in thickness on the whole of the surface. For the coloration of this glass, as for all colored glass in general, the oxides of the different metals are used. For blues the oxide of cobalt, or *safre*. For the different shades of blue, violet-blue or celestial blue, different proportions of cobalt. For a very light shade of blue for spectacles a mixture of cobalt and red oxide of iron; London smoke is obtained by a mixture of the oxides of copper, iron, and

Many overlaid colors.

Coloring materials.

For blues and shades of blue.

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manganese—a black is produced by increasing the proportions of these three oxides. Purple glass has for coloring element oxide of manganese. A glass so colored and made with soda gives a purple shade, edging on the red, while a potash glass will give a bluish purple. This color is made of a deeper blue by the addition of cobalt. The brown-purple is made with a mixture of oxide of manganese and oxide of iron. The purple of the ancients can be perfectly imitated with a mixture of oxide of manganese and red oxide of iron.

Colored sheet-glass. Coloring materials. For shades of purple.

Yellow.—A mixture of oxides of iron and manganese is used. To get this color with more facility charcoal in the shape of wood sawdust is substituted. By increasing the quantity of sawdust an orange color is produced; with still larger proportions it may turn to brown and sometimes even red or black. All books state that antimony gives a yellow coloration to glass, but it would seem that this is erroneous, for pure antimony does not color glass at all. The sulphur contained in the antimony is supposed to be the coloring agent. Glass is also tinted yellow by applying to its surface a mixture of ocher and sulphate of silver, and baking it in an oven.

For yellow and its tints.

Green.—For grass-green a mixture of black oxide of copper and oxide of iron is used. The same color may be obtained by replacing a part of these oxides by one-third of their weight of bichromate of potash. By using these substances and adding an oxide of cobalt a blue-green is obtained. Yellow oxide of uranium added to the oxides of iron and copper gives a yellow-green.

For greens.

Red or ruby.—This color is always used as a coating upon white glass, and is obtained with the brown oxide of copper, the oxides of lead and tin, scales of iron, and borax introduced into the batch and melted. The glass when melted is dipped out with a spoon and broken or ground; brown oxide of copper, oxide of lead, oxide of tin, and borax are again added and melted anew. The color of this glass is not developed until it has been repeatedly heated; in cooling it becomes perceptible. This glass requires particular care in its preparation and blowing. I believe but little of it is made successfully in this country.

For red or ruby.

Opal.—This glass is produced by adding calcined bones to the metal or batch; it is much used for gas and lamp globes, clock dials, etc. Pure cryolite has also been used for the manufacture of opal glass, and a factory was started a few years ago in Philadelphia to make this glass, under the name of hot-cast porcelain. The name was unfortunate,

For opal. Use of cryolite.

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Colored sheet-glass.

as the glass was not cast, but was pressed and blown. This misnomer, with other reasons—the principal one, perhaps, there being no economy in the use of cryolite—carried the establishment under. Our manufacturers, however, still continue to use it with good effect, but principally in the making of hollow wares. The Philadelphia factory used the following ingredients:

Cryolite glass.

Analysis.		Pounds.
	Cryolite	10
	White sand	20
	Oxide of zinc	20

The dirty, discolored oxide answers very well for this purpose. Fluor spar has also been employed for making opal glass.

Glass shades.

Round, oval, and square shades.

These shades are used in large quantities in France for protecting clocks, artificial flowers, etc. They are made in a very similar manner to the cylinders blown for window glass, with the exception that the glass must be of a very even thickness all through. This requires especial attention in blowing and reheating, in order to distribute the glass evenly throughout the mass. Oval cylinders are first blown round, then passed between two parallel pieces of wood coupled together, having the upper ends cut wider at the top. For square shades, four pieces of wood are used instead of two. Several precautions must be taken in this peculiar branch, and expert workmen are particularly necessary. Round cylinders may be cut without being annealed in ovens or leers, but oval and square shades, owing to their forms and uneven cooling of the several parts, must first be annealed before they are cut, or else, on the mere contact of the thread of hot glass to separate the bottom, they are liable to fly to pieces.

Mode of making.

Glass furnaces.

Glass furnaces.

Europe has gone much ahead of this country in the use of gas furnaces, and they have in every instance proved quite economical. The question of fuel—one of great importance in Europe—has had the effect of stimulating their adoption, and wherever they have been put up a considerable saving of fuel has been the result. France, Belgium, and England have been the foremost in adopting them. It is to be regretted that, so far, in this country but few gas furnaces have been put up. Aside from their economy, gas furnaces offer many advantages; the heat is under easier control, and may be graduated from an intense degree when

Value and importance of gas-furnaces.

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melting to one sufficiently low to work the glass. Some of the objections urged against the Siemens furnace are their great cost, difficulty of management, liability to explosions, and the necessity of keeping skillful and experienced persons to manage them. The gases, traversing in pipes from the generators to the regenerators, are constantly condensing in tarry matter, which must now and then be burned, an operation which is exceedingly disagreeable to the neighborhood, owing to the dense smoke produced. Notwithstanding these and other minor drawbacks, the great economy of 40 to 50 per cent. in the fuel, in some cases 75 per cent., and the great cleanliness and easy management of the heat, ought to be by themselves sufficient inducements for their general adoption.

Glass furnaces.

Siemens' furnace

Description.

Though these furnaces have been used quite extensively in metallurgy with great success, in this country we find but three glass-houses using them, viz: Burgin & Sons, of Philadelphia, the Lenox Plate Glass Company, and the Crystal City Plate Glass Works. In Europe we find quite a number of firms using them: in England, five plate-glass works, twelve window and bottle houses, and one flint house; in France, seven plate works, ten window and bottle works, and nine flint factories; in Germany, three plate works, eight window and bottle houses, and twelve flint works; in Belgium, four plate works, one window house, and one flint factory. These furnaces have also been introduced in Russia, Portugal, Hungary, and Austria.

Use of Siemens' furnace in U. S. glass-works.

Use in Europe.

Recently, a new system of gas furnace, without the regenerating principle, has been introduced among European manufacturers. The Boëtius furnace is much simpler in construction than the Siemens. The gas generator is somewhat similar to that of Siemens, but the gases, instead of passing through regenerators, are conducted directly to the furnace with a sufficient quantity of air, and there ignited. The air, by passing through passages under the bottom of the furnace, serves to cool the bench, and thereby receives a certain degree of heat extracted from the hot bricks. The furnaces do not cost as much to construct as a regenerating furnace, they are easy of management, and the heat can be readily regulated. With a few changes, an ordinary open fire-furnace can be altered into one of the Boëtius system. They possess all the advantages of the Siemens furnaces, with the exception that the economy of fuel is not so great. An economy of 30 per cent. is claimed, and even more with fuels of inferior quality. I am fully convinced of the advantages and convenience of gaseous fuel, and think the day is not far

Boëtius furnace.

Description.

Comparison of Boëtius & Siemens furnaces.

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Glass furnaces. distant when gas will be used not only in the melting furnaces but also in the annealing furnaces, leers, and pot-arches, as well as glory-holes; in fact, wherever fuel is used.

Many other styles of gas-generating furnaces are used in Europe, such as the Thomas & Laurens generator, using peat or wood; the Beaufume system, applied principally to generating steam; the Ten Brink, also applied to locomotives and steam-boilers, vaporizes from nine to ten kilograms of water per kilogram of bituminous coal, and is perfectly smokeless. These different systems, with suitable modifications, can be applied to glass furnaces.

Thomas & Laurens generator.

Beaufume system.

Ten Brink system.

É. Gobbe's furnace.

M. Émile Gobbe, of Aniche, France, exhibited a model of a furnace showing a combination of coke and gas furnace, with which it is claimed an economy of 70 per cent. is obtained, owing to the fact, it is said, that all the coke made can be sold to metallurgical establishments. This furnace has been applied to two glass-houses in France, but is yet under trial, and no definite results have been obtained.

Soc. Gen. de Métallurgie of Paris.

Ponsard furnace.

I also wish to call attention to a furnace which has been introduced in this country by the Société Générale de Métallurgie of Paris. These furnaces are built upon the Ponsard system, consisting of the usual Siemens generator or a hot-air generator. In the latter case the grate is suppressed and the coal is held in a fire-brick basin. The gas coming from the generator rises to the fire-chamber of the furnace, but before combustion takes place it is mixed with a sufficient proportion of hot air coming from the regenerators. The heat escaping from the fire-chamber after having done its work is conducted to a regenerator under the furnace, made somewhat in the same style as the Siemens. Instead, however, of one of the regenerators receiving the gas from the generator and the other the air to be mixed in the furnace, and having four regenerating chambers, the Ponsard system uses but one chamber. This regenerating chamber is made up of a number of passages adjoining one another, one series of which receives the hot gases after combustion and the other receiving the air to be heated by the absorption of heat from the adjoining hot canals. This system is therefore continuous, and simpler than the Siemens. It is claimed that such a regenerating furnace will last one year in a glass-house; some have been known to last three or four years when applied to other purposes than glass-making. The regulation of gas and air is under perfect control, and can be graded as circumstances require. This system is now in operation in two melting furnaces and one annealing oven in France. An economy

Description.

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of fuel from 30 to 70 per cent. is claimed by their use. As these proportions are so very wide apart, it would be interesting to know why such difference exists. Messrs. W. Sellers & Co., of Philadelphia, Pa., proprietors of the Edgemoor forges, write to the inventor that the system applied without grates works admirably with anthracite. The cost of these furnaces is said to be but two-thirds of that of the Siemens patent. *Glass furnaces.* Ponsard furnace. Sellers & Co.

In the Austrian section M. Rosenegger, of Innsbruck, Tyrol, exhibited the plan of a new gas furnace used in his factory. A gas generator furnishes the gas, which is conducted by suitable passages to the fire chamber of the melting furnace. The gas in its passage to the fire chamber is met by a current of heated air blown through iron pipes. The gas and air are regulated by suitable valves so as to insure a properly proportioned mixture. After combustion in the furnace the hot gases escape through an iron pipe which leads to a drying oven for drying sand, cullets, etc. Whenever this drying oven is not used, the heat, before escaping to the outside air, is allowed to go still further and enter another oven for drying wood, peat, etc., used as fuel. The hot air supplied for mixing with the gas is derived from a current of cold air blown into the chamber where the iron pipe for the exit of the hot gas is laid. This cold air, coming in contact with the highly heated pipe, absorbs the heat from it and, by means of other pipes, is conducted to a suitable channel, where it mixes with the gas. M. Rosenegger, the manager of the works, has these furnaces in operation for the manufacture of plate glass, and makes about 6,000 square meters of plate monthly. This furnace appears to be a simple combination of gas and hot air under pressure, but it is to be supposed that the iron pipes, being under the influence of a very hot temperature, must rapidly be destroyed by oxidation. The inventor, however, asserts that it gives entire satisfaction. Rosenegger furnace. Description.

The difficulty of obtaining good homogeneous pots, and the serious losses experienced by their breaking in the furnaces, have led inventors to devise furnaces with chambers and compartments instead of pots. Prominent among these furnaces is that of M. Fred. Siemens, of Dresden, who has applied it in his bottle factory. This furnace is constructed to take advantage of the increase of density glass acquires as it becomes more melted. It is composed of two large chambers, separated in the middle by a wall. In the first compartment the batch is put, and as the glass, under the action of the gaseous fuel, commences to melt it flows Compartment furnaces. F. Siemens furnace. Description.

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Glass furnaces.

through a passage left open in the separation wall and reaches the second chamber. Directly after leaving this chamber it passes over a low wall built across the furnace; in so doing it is exposed in a very thin layer to the action of the heat, and rapidly becomes quite liquid. The glass now continues its course forward, and, reaching a third wall having an opening at the bottom, it gradually reaches the front of the furnace or chamber, from which it is drawn for working. Thus is the operation of melting and working glass made continuous. The heat is regulated in each chamber to suit the purposes required. The layer of glass does not exceed 16 inches in thickness; the glass is therefore more accessible to the heat. These furnaces, including the gas generator, cost about $3,000.

F. Siemens' compartment furnace.

Applied to bottle making.

Applied in Europe to bottle-making, this system has given satisfactory results, but in the manufacture of window glass it has not yet proved so successful. So long as cullets or broken glass alone are used, the glass is of suitable quality; but as soon as batches are introduced the glass becomes grainy and lumpy. These defects are attributed to an imperfect refining and to the wear of the fire bricks, which are rapidly cut away and the pieces mixed with the glass. The duration of the basins, so far as experimented, has not exceeded three months. Window glass made in these furnaces was shown in the Exposition, but it appeared to be of a very imperfect quality. Should these defects be remedied, as they probably will be, these furnaces offer so many advantages and secure such an economy in fuel—at least 50 per cent.—that it would be unwise to condemn them at present.

Chagot's tank furnace.

MM. Chagot, of Blanzy, France, bottle manufacturers, constructed a gas furnace to do away with pots, and substituted a tank in their place. This furnace is 22 feet long, 6½ feet wide; the tank is 18 inches deep, and is capable of melting 26,400 pounds of metal at each operation.

Flamm's furnace.

Other styles of furnaces have been proposed, with tanks and gas generators, by M. Flamm, of France, for the manufacture of plate-glass, with what success, however, I have not been able to ascertain. Should suitable furnaces be devised to do away with pots, they will be welcomed by most of the manufacturers, who have been under the domination of the autocrat of the glass-house, *i. e.*, the pot-maker.

As to the use of liquid fuels.

In connection with the question of gas for fuel, I think it surprising that, with the abundance of liquid fuels we have in this country, no one has yet applied our petroleum successfully in glass furnaces. From recent experiments

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made in Europe it has been proved incontestibly that with suitably devised furnaces this fuel is capable of producing a great heat and a marked economy. I have heard recently that petroleum has been successfully applied to the manufacture of iron in the oil region of Pennsylvania. If this is successful with iron, why should it not be with glass?

Glass furnaces.

Use of liquid fuels.

M. Audouin, a French engineer, with a very simple apparatus for burning heavy oils of petroleum, consisting simply of an injection of oil mixed with air, succeeded in evaporating 12 to 15 kilograms of water per kilogram of oil burnt.

Audouin's system.

M. Ste. Claire Deville, the celebrated chemist, starting upon the idea of M. Audouin, devised an apparatus which he applied upon a locomotive on the "Chemin de Fer de l'Est." The fire box contained a cast-iron grate cast in one piece, the bars of which were set in front of the fire box and were quite short; the upper part of the bars were of concave, semi-circular form. Two fire brick fire bridges were built, one in front and the other back in the fire box. The whole fire box was lined with fire bricks. Air was admitted to the fire box between the grate bars as usual; the quantity admitted was regulated by means of a door. The operation is as follows: The oil arrives at the short grate bars by means of properly arranged pipes in front of the fire box, and is conducted by the concave gutters; coming in contact with the heated fire box, it is vaporized and mixed with the air which penetrates between the bars. With this simple arrangement a good combustion was obtained, and the locomotive upon which the apparatus was mounted continued to run for 2,300 miles on regular trains without stoppage. The result of the experiment showed an evaporation of 10.9 kilograms of water, while the best agglomerated coal bricks only evaporated 7.9 kilograms. These experiments were carried on with heavy tar oil from the Paris gas works.

Ste. Claire Deville's system.

Description.

Experiments.

In other experiments by M. Ste. Claire Deville, with a carefully prepared apparatus, the evaporation of water with heavy Pennsylvania petroleum reached 15.3 kilograms per kilogram of petroleum, and with ordinary petroleum 14.14 kilograms, very nearly double the amount obtained with bituminous coal. In all furnaces using petroleum it is essential that the vapor of petroleum and air should be thoroughly mixed before combustion is reached. An increase of pressure and the heating of the air have also a marked economical result.

Experiments.

Comparison of value of coal and petroleum.

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Glass furnaces. In conclusion of this chapter on furnaces I wish to say that I have the assurance of the managers of one of the largest iron mills in this country that metallurgy at the present day could not be carried on successfully and economically without the assistance of gaseous fuels. I hear with pleasure that a few of our glass manufacturers have already introduced gas furnaces, and the day is not far off when they will supplant the old direct-fire furnaces entirely.

Necessity of gas-furnaces.

Bottle-making.

Bottles.

This branch of manufacture, as carried on in Europe, differs somewhat from the others in regard to the construction of the furnaces. The materials used are required to be previously heated before they are introduced into the melting pots of the furnace. These furnaces are, therefore, constructed with upper chambers placed at each side of the furnace, and are heated by the waste heat. The furnaces are rectangular, and similar to those used in making window glass. The batch being properly mixed is introduced into the upper chambers and heated for about twenty-eight hours. Care must be taken to regulate the heat so as to prevent partial fusion, or else the cakes formed in fusing would require to be broken up. The mass upon the furnace bottom is occasionally raked and turned over with suitable iron rakes. The materials entering into the composition of the glass being very crude, if they were introduced all at once into the pots would swell up and run out. It has been the practice, therefore, to heat these materials previously, although this operation adds to the cost of the glass.

Bottle-glass furnaces.

System of working.

Consumption of coal relatively to production.

A furnace in France generally consumes about 374 pounds of coal for every 100 bottles of 28.80 ounce weight, or 1,320 pounds of coal for 220 pounds of bottles.

Operation of blowing.

The operation of blowing the bottle is very simple. A piece of glass is gathered upon the end of a hollow pipe, the workman blows through it, and gradually, by rolling and blowing, brings the lump of glass to a proper shape. The roughly-shaped bottle is now introduced into a mold—generally of iron—and by means of an air-compressing piston the glass is made to fit the mold tightly, and when taken out has the shape of a bottle. This mold is made in many instances to simply shape the lower part of the bottle, and is of metal or clay. The workman withdraws the bottle from the mold, pushes up the bottom as in champagne bottles; it is now detached from the blow-pipe by chilling and cracking the glass in applying a cold iron to its surface. The bottom of the bottle is now put into a spring

Description.

Half-molds.

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tool fitting it; the neck is reheated and properly shaped with a pair of pincers, fitting the inside and outside of the neck, provided with properly shaped forming blocks. *Bottle-making.*

This method of working is still largely followed in Europe for blowing bottles, especially those used for champagne wine, as they are considered stronger when blown in this manner, rather than in a mold forming the whole bottle. Of late, however, the use of metallic molds forming the whole bottle, is extending rapidly. By the use of these molds a uniformity of contents is secured for each bottle, and is, therefore, a security against more or less unscrupulous dealers. I do not see why bottles properly molded should not be as strong as blown bottles, if the conditions of respective temperatures of the mold and bottle are properly observed. The operation of blowing in a whole mold is certainly more expeditious than with the use of a mold shaping only a part of the bottle. I believe a whole mold is generally used in this country. The bottles having been molded or blown, are carried to the leer or annealing oven, in which they are slowly cooled in the same manner as with table and other wares. Blowing compared with molding. Whole molds.

The materials used in making glass for bottles should be as cheap as possible; transparency not being a requisite, cruder materials may be used than for other glass. Manufacturers should, therefore, study the materials they have the nearest at hand, and use them in preference to those they would have to bring from a distance. Materials for bottle-making.

The materials used in making bottle glass do not differ materially from the following:

In France. In France.

	Parts.
River sand (from the Rhône River)	100
Slacked lime	24
Sulphate of soda	8

This Rhône sand contains iron and about 20 per cent. of calcareous matter.

In Belgium. In Belgium.

	Parts.
Sand (from near Charleroi)	10
Peat-ashes from Holland	20
Sulphate of soda	15
Limestone	5
Cullets or broken pieces of glass	50

France produces annually about 100,000,000 to 120,000,000 bottles, representing a value of $4,000,000. The exportation of bottles is about 59,000,000 pounds. The price of bottles varies from $2.50 to $3.50 per 100 bottles of 21 ounces to 2.20 French production, exportation, value, and price.

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Bottle-making.

Champagne.

pounds. Champagne bottles, having to stand the pressure of the gas contained in the wine, are sold higher; they range from $4.60 to $5.60, according to quality.

Belgium bottles.

Belgium manufactures quite a large quantity of bottles, but the quality is said to be inferior to those made in France and Germany.

Exports and imports.

In 1872 Belgium exported 7,568,000 pounds of bottles, while the importation was only 1,377,000 pounds. Since that time the exports have decreased sensibly, and in 1877 they only amounted to 1,775,000 pounds, while the imports increased to 3,476,000 pounds. Of the 12 furnaces which were then in operation but 5 are now running. This shows a striking decrease, which is attributed to the neglect of the Belgian manufacturers to adopt the recent improvements in furnaces and the new methods now in operation elsewhere. It is an uncommon thing for the Belgian manufacturer not to be in the van of progress, and I scarcely know how to account for the apathy of the bottle-makers while the window-glass, hollow-ware, and plate-glass makers have shown such ability to maintain themselves up to the times.

Decrease in Belgian bottle-making.

No data of German and English production.

Germany and England also manufacture a large number of bottles, but I could procure no data to lay before my readers. What little was exhibited in the English section appeared to be of good quality.

Demijohns.

Of demijohns, which are usually made in bottle factories, I shall say but little. They are simply larger bottles, and the manner of blowing them is very similar to bottle-blowing, with the exception that the neck is not finished as in ordinary bottles, but is simply detached from the blow-pipe and smoothed with a file.

Glass-ware.

Table and other wares.

Artistic and mechanical skill involved.

Variety of goods.

Of all the branches of glass manufacturing, that of making table ware and ornamental articles is incontestably the most interesting and attractive. It requires a varied knowledge, a taste for designing, a knowledge of mechanical means and appliances, be it in pressing, molding, blowing, cutting, engraving, or decorating. The variety of goods is infinite, each new article frequently differing materially from any other made heretofore. In fact, a glass manufacturer in this branch can only hope to reach success by ceaseless and watchful attention. The low cost of an article is not a sufficient guarantee to secure sales unless it is accompanied with a tasteful designing. Economizing appliances should also be adopted at once, if found to be really such, for, in this age of machinery, no one can hope to hold supremacy

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unless he provides himself with the most perfect tools and devices. *Glass-ware.*

Many beautiful things were exhibited in Paris which, I fear, leave us far behind in the race of human competition. The artistic skill displayed by the European manufacturers is in marked contrast with our home productions. I refer more particularly to articles of luxury. European skill in designing.

In designs we are sadly behindhand. France and Bohemia are in the van. England, although manufacturing beautiful wares, so far as workmanship is concerned, is occasionally wofully behind in designs. It is a pity to see beautiful brilliant glass engraved with the greatest skill and art—a display of uncommon talent—wasted upon ugly mugs or jugs. France and Bohemia in the van.

The variety of colored glass made in Europe is really surprising. Different colored glasses are combined together in beautiful harmony, pleasing to the eye. In flint glass, which after all is the king of glass, the perfection of the cut and engraved glass is all that could be desired. Nothing is prettier than a beautiful transparent vase made of brilliant flint glass cut in deep patterns, such as flutes, diamonds, or other figures. This can only be excelled, perhaps, by the beautiful and artistically engraved pieces which were displayed at the Exposition in the British and Bohemian departments. In antique glass we find many beautiful specmens of workmanship, but, in my opinion, we have yet to see anything excelling some of our modern productions. I certainly think that we have but little, if anything, to copy from the antique wares, and am in the number of those who believe that to lament over the lost arts, as it is somewhat fashionable to do, is simply to make an exhibit of ignorance or weakness. The glass industry of the present day is as far advanced as history has ever shown it to have been, with, perhaps, a very few unimportant exceptions. Great variety of European colored glasses. Flint, the "king of glasses." Modern superior to the antique.

The manufacture of table and ornamental wares is divided into two branches, flint-glass and lime-glass. Manufacture of glass-ware divided into two classes: Flint glass, lime glass.

Flint glass is known by the English as a glass containing lead. The French and Belgians call it "crystal," but the Germans call indistinctly all white glass "crystal," whether lead enters into it or not. It would be quite desirable to have different kinds of glass designated by names conveying a meaning of their nature and composition. In this country we are laboring under the same difficulties, and glass containing small proportions of lead or none at all is often called "crystal glass." The equivalent of the "white glass" of Europe we designate under the name of "lime glass." "Crystal" glass.

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Glass-wares.

European "white glass," although made beautifully transparent, free from coloring tints to a great degree, never can attain the brilliancy of flint glass. The Bohemians and Germans, who excel in the making of lime glass, treat it in its decoration precisely as the English, French, and Belgians do with flint. Light not being reflected with that brilliancy so strikingly noticeable in flint, this glass always has a bluish-gray tint, which detracts materially from its beauty.

Lime or "white" glass inferior in brilliancy to flint glass.

The latter an English invention.

We owe the invention of flint glass to the English. Wood was used as a fuel in the beginning of glass making, but it having become scarce in England coal was resorted to as a substitute. This fuel, however, producing a great quantity of smoke in the furnace, many impurities were mixed with the glass and gave it a coloring. To obviate this difficulty, pots, which had been made heretofore without covers, were now covered. This, however, reduced the temperature of the contents of the pots, and it was found that glass made with the ordinary mixtures was too hard to melt. Red lead was then introduced as a flux; this remedied the difficulty. To this day the English retain the supremacy in the manufacture of flint glass; in color, brilliancy, and superior purity of metal, it is not surpassed by any other country. France and Belgium are also making large quantities of flint-glass wares, and I particularly noticed that since 1867 French flint had been materially improved. The peculiar grayish tint which distinguished the French from the English then has now disappeared, and French flint is nearly equal to the English.

How flint glass originated.

England retains supremacy.

Improvement in French flint glass.

Belgium has somewhat departed from the manufacture of pure flint glass, and to meet the demand for cheap wares has been making ordinary white glass with a small proportion of lead added. The manufacture of flint glass in Belgium, at the present day, amounts to $1,600,000. In 1876 the exportation amounted to $340,000.

Half-flint glass.

Materials of flint glass.

The materials used in flint-glass making are potash, red lead, sand, and small proportions of oxide of manganese as a corrector of color.

Use of potash.

Potash is used in the form of carbonate, and should be as free as possible from sulphate, chlorate, soda salts, iron, and organic matters. Sometimes 10 to 20 per cent. of niter is substituted for soda, giving a very fine glass. Its use, however, is somewhat objectionable, as it destroys pots very rapidly; its high-cost price is another objection. The English use potash coming from America; it is refined by manufacturers, who sell the purified article direct to the glass-makers. France draws her potash from America, Tuscany,

Sources of potash.

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and Germany. The potash contained in the residuum of the beet-root sugar-making is also used. *Glass-ware.*

Red lead.—The selection of leads for making red lead should be very particular; the metal should be free from copper, iron, and even silver. Zinc and antimony are less troublesome. In the large establishments of France red lead is generally made on the premises. The best lead is drawn from Spain. Germany has also a few superior brands. Selection of lead for glass-making.

As many manufacturers cannot afford to manufacture their own red lead, and are obliged to purchase it from the trade, I will briefly show how the presence of copper can be de ected. Tests of purity of lead.

Take a determined quantity of red lead, say 50 grams; add, say, 50 centimeters of concentrated ammonia. The bottle should be big enough to contain about 200 cubic centimeters; shake now and then. In a few days if a blue coloration should take place it is an indication of the presence of copper; the deeper the color the larger the quantity. Litharge may be treated in the same manner. If red lead or litharge give a decided blue tint to glass, they must be rejected as containing iron. The use of litharge has often been tried instead of red lead, but the result has never been satisfactory, and always produces a glass of inferior quality.

Cullets or broken glass.—The glass remaining upon the blow-pipes after an article has been blown is saved for use over again. This glass contains oxide of iron detached from the pipes in cleaning them; since it would be quite unfit for use in this state, it is necessary to eliminate the iron. For this purpose the following process is employed: Diluted sulphuric acid is introduced into large iron boxes lined with lead and heated to 180 degrees Fah. The liquid should be stirred now and then. Twelve hours or more afterwards the iron is nearly all dissolved; the cullets should then be taken up, washed, and dried. Cullets. Mode of purifying.

Sand.—The sand used in flint-glass making should be of the greatest purity, and if it contains iron the same treatment as indicated for cleaning cullets is resorted to with very good effect. In all cases, however, sand should be washed in water before using it. Sand.

Flint glass in Europe is generally made with the following mixture: Composition of flint glass.

	Parts.
Silica (sand)	100
Red lead	66⅔
Carbonate of potash	33⅓
	200

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Glass-ware.

This proportion is usually followed by all manufacturers. It shows: 1 part carbonate of potash; 2 parts red lead; 3 parts sand. It is seldom deviated from and produces a very good metal. To correct the color small proportions of oxide of manganese are sometimes added. To the above mixture a quantity of cullets should be added at least equal to the weight of the sand.

Use of boracic acid—

Other materials have been tried in making flint glass. Boracic acid has been used by MM. Maës and Clémandot, of Clichy, near Paris. By the use of this flux the composi-

permits substitution of other ingredients.

tion of glass can be greatly modified; oxide of zinc may take the place of red lead; lime, soda, or barytes may be used instead of potash. These substitutions, in connection with boracic acid, have produced a beautiful glass, suitable for table ware or optical purposes, which is remarkable for

Style of furnaces at Clichy.

limpidity, whiteness, and brilliancy. The furnaces used are of the direct-fire style, containing 8 to 10 pots of a capacity of about 600 pounds, heated by wood or coal. As wood has become quite scarce in many localities, coal is gradually being substituted. The direct-fire furnaces are also gradually passing away, and the Siemens and Boëtius gas furnaces are taking their places. Economy of fuel with European manufacturers is a question of more importance than with us.

Fuel economized by gas-furnaces.

With abundance of fuel in this country, we have not felt the necessity of economy to such a degree as they have. Gas furnaces possess so many advantages that their use should be generally adopted; those burning coal can now be run

Didierjean.

with open instead of closed pots. Mr. Didierjean, of the Saint Louis Glass Works succeeded in so directing a mixture of gas and air in suitable proportions and directions that the former oxidation of glass in open pots is now avoided.

Mode of melting and working.

In the ordinary furnaces eight or nine hours are necessary to melt glass, the refining taking about one or two hours more. The blowers work for eleven hours, with half an hour's rest at noon. Work begins and ends every day at the same hours, from 5 a. m. to 4 p. m., continuing for six days every week.

English method of working furnaces.

In England the custom is entirely different. The furnaces and pots are very large; the pots contain as much as 2,000 pounds, and require from forty-eight to sixty hours' firing before melting. The glass being melted, work is continuous day and night without intermission for four or four and a half days, until the glass is all worked up. This does not appear to be a wise method of working. The glass remaining so long melted in the pots is apt to lose its good quality and homogeneousness, also causing striæ to appear

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Glass-ware.

towards the end, sometimes ending in devitrification. Each set of workmen in France is composed of twelve persons, while in England there are only four, viz: a finisher, a gatherer, a blower, and a boy. As the latter mode of working must necessarily occupy a large part of the high-priced workmen in doing the work that could be performed by cheaper hands and by subdividing the labor, it does not seem to me to be as economical as the French mode.

English mode of working furnaces.

The English method, however, has some advantages. As the furnaces are kept at a low heat for long periods while working, this naturally increases the life of the furnaces. While the French furnaces rarely last over one year or eighteen months, and the pots from six weeks to two months, the English frequently preserve their furnaces from six to eight years, provided the benches are repaired every two years; the pots last on an average from four to six and sometimes seven months. The frequent alternate cooling and heating of the French furnaces causes them to disintegrate much more rapidly than the English. The English method, however, requires a larger quantity of coal, but with their cheap coals this does not weigh much in a question of general economy.

Advantages of English system.

Requires more fuel, however.

English leers.

The leer or annealing oven does not differ from those used in this country. It is the usual long furnace, heated in front with two fire-places, the flame striking against the arched top and reverberating the heat upon the wares placed in iron pans traveling on rails.

Glory-hole.

The "glory-hole" or reheating furnace is also of the ordinary style found in this country.

Glass-working tools.

The tools are of the usual kind, and but little novelty is found in them. Foreign manufacturers have not become so familiarized with mechanical appliances as we have in this country. The American pressed glass, which I sent for and exhibited myself, at my own expense, drew from the European manufacturers exclamations of astonishment when they saw the clearness, smoothness, and brilliancy of this glass, the freedom from mold-marks, and the superior execution in general. Frequent inquiries were made as to the mode of working. This was a positive proof that they consider us superior in that line. In fact, many manufacturers frankly acknowledged to me our uncontested superiority in pressed glass. Nothing could be seen elsewhere in the Exposition equaling our samples.

American pressed glass.

Superior to European.

Superiority of European workmen.

As a great many wares are still blown simply with the few tools of the craft, the foreign workman as a general thing is well skilled and superior to his American brother.

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Glass-ware.

To illustrate how few new introductions have been made in the glass-blower's tools, I have been told that the use of "snaps" to hold pieces while reheating is of recent origin in Europe, as is also the use of a whole iron mold for bottles, instead of the half mold, which had been used for many years.

Wooden molds recommended.

I wish to recommend to our manufacturers the use of wooden molds, knowing how in France, Belgium, and Bohemia these molds have been the means of cheapening production and insuring regularity. There are scarcely any blown articles made without the help of these molds. They are cheap, and, where a very large quantity of pieces is not wanted, they are the best kind of molds yet found to produce clear, smooth wares. For the making of current articles, needed in great quantities, wooden molds do not answer as well, as they do not hold their outlines sharp long enough, owing to the slow burning or charring of the inside. To avoid this difficulty iron molds have been used; they are lubricated with a fatty or resinous substance, which is occasionally renewed. The same clearness of glass cannot be obtained, however, as with wooden molds. In the Bohemian exhibits I saw a quantity of beautiful vases and other articles which I was told had been blown in wooden molds. These wares are very regular and beautiful in shape.

Their advantages and disadvantages.

A new practice has recently been introduced in France, to which I also wish to call the attention of our glass-makers. It is the invention of M. Clémandot, a celebrated and competent glass manufacturer. I refer to the coating with nickel of molds, blow-pipes, and tools used in glass-blowing. This coating prevents the oxide of iron from being introduced into glass through impure cullets. This process has been applied with success in several glass works, and I should like to see it tried here. A coating of nickel is readily imparted by immersing the objects in a plating bath of sulphate of nickel and ammonia for several hours.

Nickel plating of tools.

Process of blowing flint glass-ware.

I shall not undertake to describe the blowing processes for table and other wares but very briefly. It is the skill of the workmen which secures the reputation of glass works in Europe, since mechanical means are but little known or used. The process of blowing consists in dipping a metallic "blow-pipe" into the mass of glass contained in the pot. The blow-pipe being colder than the glass, the latter adheres firmly to it, and, owing to the cooling action of the ambient air, gradually becomes solidified, but it should be worked

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Glass-ware.

while yet plastic. The workman now blows through the pipe and gradually forms a hollow ball, which, by means of his few simple tools, he brings to the proper shape so as to form the desired article. The tools of the glass-blower are but few; they are the blow-pipe, pinchers, shears, calipers, a marver or iron plate, a bench, and a few other primitive so-called tools.

Blowing flint glass-ware.

Doubled or flashed glass.

The so-called "doubled glass," known as "flashed glass" in this country, is a glass made of several colors superposed. It is worked in a different manner from plain glass. Colored glass when first made is generally drawn into sticks of a certain length and annealed. Suppose we now wish to blow an article made of white glass with a thin sheet of outside colored glass. A stick of colored glass is taken and heated gradually; the workman now takes up this stick on the end of his "ponty"—an iron rod upon which a little hot glass has been gathered—and heats the glass in the "glory-hole." When this is sufficiently plastic a quantity is cut off and attached to a blow-pipe also having a small lump of hot glass at its end. The colored lump is now heated again and blown in the usual way into a hollow ball. This ball is opened and formed into the shape of a cup. In the mean time another workman has gathered and blown another sphere of white glass of a suitable size. This sphere is now put into the cup-shaped colored glass, blown, and rubbed together while hot so as to make them adhere. We now have a ball of white glass inside and colored glass outside. This may be finished to any shape desired, in the usual way, with molds or tools.

Mode of making.

Great variety of articles manufactured.

The variety of articles made in glass is so great that I cannot possibly describe the different processes. It is not thought to be within the scope of such report as this to give detailed descriptions. I wish, however, to impress on the minds of our manufacturers the necessity, growing more every day, of traveling out of the now beaten path of ordinary goods, and taking up the making of the beautiful fancy articles which were to be seen in such profusion in the Exhibition. We are sadly behind the times in these wares; we are at the head in pressed glass, why should we not strive also to reach that position in fancy wares? Our deficiency is particularly striking in the making of doubled, trebled, and quadrupled colored glass; the blowing of solid ribbed vases; in articles having cameos on the surface; vases blown of two colored glasses, with relief designs, which are subsequently cut away in alternate places so as to show faces of different colored glass; mottled colored

American neglect to enter upon the making fancy glass.

Articles which we should make.

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Glass-ware. glass, imitating marble; the blowing of minute hollow tubes between two layers of glass; the spinning of colored glass threads upon the surface of articles; and the endless variety of Venetian fancy goods. The same may be said of bronzed and white iridescent glass, the yellow and green aventurine, etc. I notice, however, of late, a tendency to introduce colored glass by our manufacturers, and I have already seen very handsome articles made of solid colored glass.

Articles which we might make.

Glass cutting. Cutting and engraving are two processes very similar. The cutting or grinding of glass is usually done with four kinds of grinding wheels or disks, revolved by power: (1) a cast or wrought iron wheel; (2) a stone wheel of very close grain; (3) a wooden wheel; and (4) a cork wheel. The operation is briefly as follows: The iron wheel, being mounted upon a suitable frame, is made to revolve; over the wheel a hopper, containing sand and water, is hung, the wet sand falling on the periphery of the wheel. The piece of glass being held against the face of the wheel, the sand, by its abrading action, grinds away the glass. The next operation is to take the ground object, which now presents a very rough surface, and apply it against the revolving stone wheel, kept moist by a stream of water running out of the hopper. This operation removes the asperities produced by the first operation, but this does not restore the former brilliancy of the glass. To partially produce this polish the glass is next held against a revolving wooden wheel, usually of poplar or willow. A wet pumice-stone powder is occasionally spread over the wheel. The glass is now quite smooth and free from scratches, but is not sufficiently polished. The cork wheel is now used for the last operation; it is sprinkled over with "tin putty" or colcothar. The polishing action of the cork wheel completely restores to the glass the polish and brilliancy which it originally possessed.

Tools.

Process.

Accuracy in cutting the result of skill. To cut glass with such a scantiness of mechanical means, it will be seen readily, necessitates a long practice and skill in the workmen, as they have nothing but the eye to depend upon for guidance. Nevertheless, with such limited means, the most beautiful designs are cut with wonderful effect.

Deficiency of mechanical aids. But upon a close examination the work is often found very irregular. When the operation has to be repeated over again, and the same patterns have to be cut, it is exceedingly difficult to obtain regularity in the work, and to make the pieces alike. In pressing glass in molds having the shape and design desired, the operation being entirely mechanical, and consequently accurate, it is an easy matter to produce a large number of pieces perfectly alike. Pressed

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glass, however, never can attain the beauty and perfection of cut glass. The molds cannot produce the outlines and angles sharp enough, and should they be produced in pressing they would be blunted in reheating or fire-polishing. Cut and pressed glass will, therefore, each maintain its respective sphere. *Glass-ware.* Comparison of cut and pressed glass.

Several attempts have been made to cut glass by machinery, but until recently they have met with poor success. In France a machine has just been brought out for cutting several tumblers at a time. This machine was in operation at the Exhibition, but showing only the cutting of one glass at a time. Since the inventor called it an experimental machine only, not completed, I could not judge of its merits or of the improvements he contemplates making. As I saw the machine in operation, however, I do not think it will ever realize the sanguine expectations of the inventor. The tumbler is mounted upon a holder, pressing upon the face of a horizontally revolving wheel; the holder is weighted sufficiently to give the proper pressure to grind out the flutes. The machine is automatic, raising and revolving the tumbler a sufficient distance to cut the next flute and again lowering it against the grinding wheel. The operation is repeated until all the flutes around the tumbler are cut. French glass-cutting machine.

Another glass-cutting machine has been introduced in Germany, but since the German Government did not take part in the Exhibition, except in the fine arts, I had no opportunity of seeing it in operation. From an examination of the drawings which I saw I am inclined to think that the same defects exist in this as are to be found in the French machine; neither of them regulate the penetration of the grinding wheel, and simply depend upon pressure for action. This German machine, however, seems to be adapted to a greater variety of work than the French. German glass-cutting machine.

In the American section samples of glass cut by machinery were exhibited by Mr. J. P. Colné, the result of a joint invention with the writer. These were the only machine-cut articles in the Exhibition, and excited the curiosity of the foreign manufacturers, owing to the beauty and regularity of the work. These samples consisted of decanters, goblets, sugar bowls, mustard pots, tumblers, etc., of different shapes and styles of cutting. The machine was not on exhibition, but it has since been put in operation very successfully in France by the inventors. It is not entirely automatic, but is adapted to cut all geometrical American glass-cutting machine. J. P. Colné.

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Glass-ware.

shapes and patterns, as well as a great variety of styles of cutting, and does not require any skill in the person working it, as the penetration is perfectly regulated. The rapidity, the regularity, and the perfection of the work done with this machine insures a great saving in the original cost price of cut articles.

Effective glass machinery demanded.

In glass-cutting, as in other branches of the glass manufacture, I recommend the use of mechanical means to cheapen and perfect the production of wares. We have seen the benefits of machinery in the ingenious inventions of molds and presses now so extensively worked in our establishments. Machinery for cutting glass must necessarily work the same results.

Glass engraving.

Engraving glass is a similar process to cutting, the difference being in the tools. In engraving, instead of using a large iron wheel with sand and water, a very small copper disk with emery and oil are used. To engrave glass requires very skillful workmen. The work produced by Bohemian and English engravers is truly wonderful. France and Belgium also produce very fine work, but the artists, or at least many of them, are of Bohemian origin.

Bohemia and England in the van.

Glass etching by hydrofluoric acid.

Etching in clear and dead white grounds by means of hydrofluoric acid has been carried to a great state of perfection in Europe, particularly in France. This comparatively new process of engraving is capable of producing beautiful work at a greatly reduced price. By means of properly prepared designs with the well-known printing processes on paper, the most intricate and beautiful patterns may be etched upon glass with great perfection. Of late years the dead-white etching upon clear glass has been carried to a high degree of success in France; in fact, it can be said that from the time this style of ornamenting glass was discovered dates the successful introduction of etching on glass.

Sand-blast process.

The sand-blast process has quite recently been introduced into England and Belgium, but, so far, has taken no footing in France, with the exception of one establishment, which is preparing, and may by this time have made an experimental trial. I think that so valuable an invention must make its way even against the competition of etching by acid. In this country this style of engraving has proved quite a success on flat surfaces or sheet-glass; I wish we could see it applied more generally to our table and fancy wares, lamps, and gas globes. I have already seen some very fair applications of sand engraving to ornamenting shades, globes, etc. Sand engraving in combination with

A success on sheet glass, and applicable to wares.

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enamel painting would produce very pretty effects, and I hope to see it tried by some of our glass-makers. *Glass-ware.*

Lime or white glass.—The center of manufacture of this glass is in Germany. Bohemia is especially famous for its "white glass." The Bohemians make in this glass all articles made elsewhere in flint; in fact, they blow it and decorate it precisely in the same manner. The Bohemian display of fancy colored, highly decorated, cut, engraved, and painted glass was truly beautiful. The color of their "white glass," however pure the materials may have been, and however carefully it may have been made, never reaches the brilliancy and limpidity of flint-glass. Bohemian white glass being much harder than flint, it requires to be worked promptly, since it cannot stand reheating as well as lead-glass. This peculiarity has led Bohemians to adopt a special system or method of blowing. To avoid frequent reheating, articles are blown at one or at as few operations as possible. For this purpose wooden molds almost exclusively are used, so that one blowing is sufficient to give the required shape. This, to a great measure, cheapens their productions, but these molds are of especial advantage in giving to their wares the beautiful shapes we are accustomed to see in their fancy vases. Although labor is very cheap in Bohemia, I doubt whether skilled labor could be procured at the low prices usually paid were these pieces to be blown by hand instead of the wooden molds. England to this day refuses, or rather the workmen do, to use any wooden molds. Any attempt to introduce these molds would be followed at once by a strike in that unfortunate strike-ridden country. It is true, I have seen very regularly blown wares coming from England, but they must be the work of highly-skilled workmen, who must naturally be but few and well paid. Wooden molds, formerly a secret to the French manufacturer, are now used very extensively.

Lime-glass; the "white glass" of Bohemia.

Not as brilliant as flint glass, but harder.

Bohemian method of blowing.

Wooden molds.

Wooden molds not used in England.

Used in France.

Articles blown in wooden molds are sometimes opened with shears and finished before being annealed, but the great mass of them are sent to the leer without being opened. The operation of cutting open is done with curved hot irons of about the same diameter as the piece, which are held against it while it is being revolved. This produces a slightly heated ring, and, as glass is a bad conductor of heat, the heated circle does not extend to the mass. By wetting the heated circle a rupture takes place and extends all the way around the piece. A slight blow detaches the top, leaving the object opened. The edge, which is left an-

Finishing blown articles of lime glass.

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Glass-ware. gular and cutting, is smoothed and finished by grinding and polishing.

Bohemian glass-houses. Bohemian manufacturers work in a very primitive manner. The glass-houses are generally built in the midst of forests, made of very rude frame buildings. The furnaces

Furnaces. are very small, burn wood, and contain only seven or eight

Division of the work— very small pots. Glass-making in Bohemia is divided into

Blowers. two distinct branches: The glass-blowers who generally manufacture the rough, unfinished articles, and the glass-refiners, so called, who cut, engrave, and decorate them in their various well-known and skillful ways. A few factories do the whole work in the same establishment; the larger number simply blow or mold articles and sell them to the glass-refiners. Since these factories burn wood, the furnaces are generally placed in the midst of timber, and as the fuel recedes from the factories, it is found more economical to move the furnace than to bring the fuel to it. Furnaces are therefore very unstable affairs. This state of affairs prevents owners of glass works from carrying on the

Refiners. decoration and finishing of glass in the neighborhood of the furnaces, since for this purpose more substantial buildings are required. Thus gradually the so-called glass refining became separated from the blowing and became an entirely

Statistics of glass-working. separate branch. The statistics published in the Austro-Hungarian catalogue of the Exposition show that in 1876 there were 177 glass-houses, with 273 furnaces and 1,663 pots, employing 7,100 workmen. As I have already stated,

Fuel. wood is the principal fuel; 47 establishments, however, burn coal, 7 are run with wood and coal, 6 with wood and peat, and 117 use wood exclusively. These fuels are used in direct-fire furnaces, or are first distilled into gases and burned in gas furnaces. Quartz used in making glass is

Materials. found in abundance in the vicinage of the works. Chemicals employed are generally procured from the chemical works of the country. Soda is procured from abroad. Of late years carbonate of soda has taken the place of potash, generally used by the Bohemians; owing to its lower price, it is gradually introduced into all the different kinds of glass they make. Recently, however, sulphate of soda, being still cheaper, is taking the place of the carbonate.

Statistics of window-glass works of Austria. There are 63 window-glass works in Austria making cylinder glass, 46 making cast glass, and 56 making both; 12 make drawn glass, made into tubes, sticks, drops, spun glass, etc. Most of the works are situated in Bohemia. In the Böhmerwald district wood is used as fuel, but in North Bohemia coal takes its place. The "glass refineries" are found in

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Glass-ware.

the districts of Haïda and Gablonz, where the workmen mostly work at home. The finishing of plate-glass is carried on in the Pelsen district, where 44 establishments are to be found for grinding and finishing, and 8 for silvering. The pressed, cut, and spun glass factories are situated in the district of Gablonz and Tannwald, in North Bohemia. In the township of Rechenberg 2,222 establishments are to be found, some of them, however, very small. The total annual production of Austria reaches at least $12,000,000. The government encourages the glass industry by all means in its power. Museums, drawing, and art schools have been opened in several places, and a practical school was founded in 1857 in Steinschönau.

Finishing works for plate-glass.

Production of Austria.

Bohemian white glass is a strong rival to flint; it is well melted, hard, homogeneous, and brilliant; it can be cut and engraved with advantage. It, however, seems to have a slight yellow or blue tinge, notwithstanding the care manufacturers take for getting rid of impurities in the materials used. This glass, containing a great percentage of silica, is very hard and well calculated to stand the fire of the muffle in decorating it. It also resists very well the action of chemicals, and is invaluable in the laboratory.

Characteristics of Bohemian white glass.

Bohemians excel in making colored pot-metal or glass colored in the mass. The larger number of colors now made have been discovered by them. They are excellent engravers, and whenever very fine engraving is found it is generally the work of a Bohemian or of a descendant of that country. Sand is seldom used, but quartz is quite abundant and is substituted for it. It is prepared by heating it and throwing it into cold water, then pulverized in mills. Lime is found in profusion in the country.

Bohemian colored glass.

Engravers

The average Bohemian glass contains the following proportions:

Composition of Bohemian glass.

	Parts.
Pulverized quartz	100
Carbonate of potash	28 to 32
Slacked lime	13 to 15
Oxide of manganese	1
Arsenic	3

Sometimes a few hundredths of saltpeter, borax, and red lead are added.

Bohemian furnaces are elliptical in form; the pots do not hold more than 160 pounds of mixture, requiring at least eighteen hours to melt. At the side and above the furnace is built a chamber to receive the waste heat escaping from the combustion. This chamber is used for annealing finished wares, heating quartz, and burning lime. When

Furnaces

Annealing chamber.

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Glass-ware.

wood is used as a fuel a third chamber is built on top of the latter, and is used for drying wood and preparing it for fuel. There are only five working days per week in Bohemian factories.

Half-flint ware of Belgium.

Belgium, a country having a high reputation for glass-making, does not follow the Bohemian system, but manufactures for common table wares a half-flint glass. This glass, however, lacks the beauty of white lime glass of Bohemia; it is of a grayish-blue color, which is not pleasant to the eye.

Exports.

Belgium, in 1867, exported $146,000 worth of lime or white glass; in 1876 the importation had increased to $670,000.

French lime-glass.

The French make a white or lime glass somewhat with the same materials as the Bohemians. The use of sulphate of soda of late has cheapened this glass materially, and the goods produced are comparatively good. The lime or white glass of the French is called sometimes half-crystal. It is usually made in the following proportions:

Composition of French lime-glass.

	Kilograms.
Sand	200
Carbonate of soda	66
Lime	50

Or, sometimes,

Sand	300
Sulphate of soda	170
Slacked lime	75
Ground charcoal	10

Sometimes a few hundredths of red lead are added to render the glass more fusible and brilliant. If potash were as cheap as soda it would be preferable for making glass, and would give a better color to it. I am not aware that England works any lime glass. Although I made repeated inquiries, verbally and in writing, I found great difficulty in obtaining information in regard to the status of glass manufacturing in England; nor did I find any documents which could throw any light upon it. Germany manufactures white or lime glass in great quantities, but as she was not an exhibitor in Paris I was not able to get any information in regard to this branch of her industry.

No lime-glass works in England.

Large production of lime-glass in Germany.

Slag-glass.

Glass from iron-furnace slag.

Although the manufacture of glass from the slag of blast furnaces may not be considered strictly as a branch of the glass manufacture, yet I have thought that a few remarks upon the subject might draw the attention of our iron and glass manufacturers, and might, perhaps, result in establish-

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ing this new branch of manufacture, which is already carried on so successfully in Europe. *Slag-glass.*

In the manufacture of iron with blast furnaces there is formed more or less of a dark-colored glass known as slag or scoria. This refuse matter accumulates around furnaces, and must be carried away in order to get rid of it. It is almost as great a nuisance as the coal dust of our anthracite coal mines. Abundance of iron-furnace slag.

Within three or four years the manufacture of articles made from slag has been carried on successfully in England in the iron districts. In the Cleveland district alone from three to four million of tons of slag are made annually. Bricks, paving stones and slabs, concrete panels, tiles, etc., are now made from this material. I believe it capable of being introduced as a building material in many ways, and that ready means for its application would soon be discovered should its manufacture be carried on in this country. In England we read of an iron manufacturer offering to furnish to any glass-maker who wishes to establish glass works in his neighborhood three million of tons of slag for nothing. Doubtlessly, there would be plenty of our iron-makers who would show as much generosity to any one wishing to embark in this business. Manufacture of articles in England from slag. Bricks, slabs, and tiles. Slag in large quantities offered free.

Slag-glass, in its natural state, is too dark to be applied to the purposes for which ordinary white glass is used, but it can readily be made useful in all articles of cheap and ordinary use where slightly colored glass is not objectionable. As a competitor against ordinary glass, slag-glass has a great advantage in its low price, since the larger part of its ingredients could be had for nothing. Uses of slag-glass.

In connection with blast furnaces it would be an easy matter to erect glass works, and, by proper arrangements, to transfer the hot slag into glass furnaces, and thereby retain a large part of the heat already developed. Should the slag not contain a sufficient quantity of silica, an additional amount of sand might be added. Should it be too silicious, and thereby produce a too hard and brittle glass, the required quantity of sulphate of soda might be added to produce a glass of the ordinary conditions. The installation of the furnaces might be so arranged as to utilize some of the waste gases of the blast furnaces. The furnaces could be built without pots, and tank furnaces, similar to those used in the iron manufacture, might be used with slight modifications, or furnaces in the style of Siemens's continuous melting plan. With the exception of the color, this glass could be produced in all degree of hardness and softness Slag-glass works in connection with blast furnaces. Remedying defects of composition. Utilization of waste heat of blast furnaces.

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Slag-glass. suitable for different purposes. For the terra-cotta articles now so extensively used in Europe those made with slag-glass could be substituted, and so made and ornamented as to be a vastly cheaper substitute.

Slag-wool. The utilization of slag in another direction has already been introduced in this country. At the Clove Furnace, Greenwood Iron Works, Orange County, New York, a manufactory has been started for the production of mineral wool, so called, used as a non-conducting substance for lining roofs, protection against fire, etc. The slag in its molten state is drawn from the blast furnace and emptied into a tank carried upon a small wheel truck or car. The car runs upon a railway and is carried opposite the wool-house, which is lined inside with thin sheet-iron. There are two floors, but the upper one does not run the whole distance of the building. The operation is as follows: The car filled with hot glass is brought opposite the apertures in the wool-house, the glass is allowed to drop upon a runner in a small stream, steam is conveyed under the runner, and as the glass drops it is met by the jet of steam, which blows it with great force inside of the wool-house in very thin filaments. In order to obtain proper filaments the glass must not be too liquid, but of a sufficient degree of plasticity only. The effect of the steam or air jet is to detach from the flowing stream a small hot shot, which furnishes the basis for the filament; the smaller the shot the smaller the filaments. It has been found that by regulating the heat of the flowing stream and the strength of the steam jet, the shot remaining may be reduced to less than one-sixteenth of an inch and is not necessary to be separated from the wool, as it does not impair its effect. The lightest wool, carried to the upper floor, is entirely free from the residuary balls.

Clove Furnace, N. Y.

Mode employed.

Operation.

Uses of the mineral wool. This mineral wool being non-combustible, and of very fine texture, answers the conditions for a good non-conductor of heat. It has been applied as a coating for steam-boilers, engine cylinders, steam-domes, pipes, a lining for ice-houses, brewers' vaults, refrigerators, etc. It should be applied loose, without crushing, as although it is perfectly elastic yet it is apt to be broken in small pieces which easily escape confinement. This wool has received an extensive application in England under the name of slag-wool; and in Germany, where it is known as silicate cotton, a cubic foot costs from 10 to 20 cents, according to fineness of filaments.

Also known as silicate cotton.

Glass-wool. Fine glass-wool or glass-cotton is made in Austria in very fine white and colored filaments, and is used for the

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manufacture of cloth, laces, ladies' fancy articles, etc. I do not believe, however, that this glass is capable of a very wide range of application, since it is subject to break into short fibers whenever it is submitted to a certain pressure while folded. A quantity of this glass wool I brought over from the Exhibition and put away in an envelope, on being opened, shows a pretty large percentage of white, short, broken fibers settled at the bottom. This would indicate that glass, even in such an attenuated condition, still retains to a certain degree the peculiar brittleness of all glass. In the weaving process a large proportion of these fibers must be lost, and a fabric folded and put under pressure could not resist the deterioration of such a treatment, and would show a number of broken fibers in the folded places.

Glass-wool.

Suitable for special uses, but incapable of wide application owing to its fragility.

Mechanical tools.

Mechanical tools.

While Europe, to attain perfection in manufacturing, has had to depend upon the superior skill of workmen, in this country, being entirely deprived of skilled labor in the beginning, we have had to depend upon the substitute of mechanical devices. The inventive genius of our people proves the old adage, "Necessity is the mother of invention" to be a true one. Necessity has pointed out the want to be supplied. This is one-half of the invention, as, when we know what we want, we can always find mechanical means to accomplish our end. The inventive genius of this country has also been greatly fostered by our wise patent laws. The question of self-interest or profit is a factor in inventing which cannot be ignored. It is to be hoped that the attempts which have been made lately to procure national legislation to use by force the property of inventors and to deprive them of its control will be frowned down by all those who have the prosperity of this country at heart, and who have a well-defined idea of the sacred right of property, be it patent property or any other.

American facility in invention.

Our wise patent laws.

In glass-making, as in other industries, the scarcity of skilled labor drove our people to devise means for accomplishing work without its aid. We were naturally driven to machinery. To obviate hand-blowing, a process which is very difficult to master, shaping with press and iron molds was substituted. The beneficial results of this invention are incalculable. It placed our manufacturers in a position to make regular and cheap wares, while skilled labor became no longer necessary. The simplicity of the operation of pressing glass was such that in a very

Scarcity of skilled labor our incentive to the invention of machinery.

Iron molds and presses.

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Mechanical tools. short time men could be trained to perform the work. It does not require much knowledge to train men to gather glass, drop it into a mold, and cut off a sufficient quantity.

The mold and plunger press. The glass now being in the iron mold, a plunger is made to press the plastic mass, and in solidifying, by cooling, the objects retain the form of the mold and the plunger. A simpler operation can scarcely be devised. This invention was the royal road to success. Then came improvements fast and thick in combinations of the different pieces of molds, improvements in presses, and tools for holding the pieces while being fire-polished.

Goblet press. One of the most important inventions in pressing, one which in my opinion was the foundation of goblet-pressing,

Cup-shaped foot. is the cup-shape given to the foot in the mold instead of pressing it flat as in the finished shape. This invention is evidently based upon the principle that in flowing sharp angles should be avoided and curves substituted. By this means glass is made to flow gradually in easy curves and the wrinkling of surfaces is avoided. It is a principle which should never be forgotten by inventors—a principle of the utmost importance to produce smooth, clear, and even surfaces.

Difficulty of producing sharp angles in the press. One of the defects of pressed glass, and which shows its inferiority to cut glass, is the difficulty of producing and maintaining sharp angles. If we succeed in obtaining these

Loss of sharpness in fire-polishing. angles to our satisfaction in the mold, in fire-polishing and in reheating we are very apt to lose them. The heat taking effect at first upon the thinnest parts, the angles, softens them and the sharpness is lost. To obviate this to a certain degree, it has been imagined to so shape the iron molds that the angles stand in bolder reliefs, viz, the angles are lengthened in the molds. It will be seen that if the heat softens these angles they yet stand enough in relief to give marked and distinct outlines.

Mode of obviating uneven surfaces. To obviate the uneven surface of flat or fluted articles, the molds have been constructed so as to make the flutes deeper in the middle, and with angles slanting towards this point. It will be seen that a flute composed of two angles tending to the center is not as likely to show defects as if it was of a plain flat surface. Although these improvements have accomplished much towards attaining perfection, pressed glass will never attain the beauty of cut glass.

Fins left at the partings of the molds. Another defect of pressed ware is the marks left on the glass at points where the different pieces of the mold are joined together. However skillfully the molds may be made, in course of time the joints will work loose through the expansion and contraction of the metal, and the glass

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will gradually be pressed in the loose spaces of the joints, thereby imprinting on the surface of the articles ribs or sharp threads, marring the beauty of the work. Among the notable improvements made in molds and presses, the following are some of the more particularly worthy of notice:

Mechanical tools.

Glass-presses.

To obviate the mold-marks, molds have been made to open at such places and parts of the design that they can scarcely be seen—in goblets, for instance, the marks are left on the edges of angles; also in combining the molds so as to leave the marks on the edge of the scallop made by the top of flutes in a goblet or tumbler.

Suppressing mold-marks.

Molds have been made with different mechanical devices to operate a plunger above and another below, in order to form two cavities, such as the cup-shaped foot and the bowl of a goblet. Letters, monograms, and ornaments have been made by introducing lateral pieces in molds containing the proper designs. These pieces are changeable, and the same shaped article may be made having different lettering, etc. Curved tubes and glass slippers have been made by giving the plunger a descending curvilinear instead of a vertical motion.

Double-plunger press.

Lettering and designs.

Molding curved hollow articles.

Lamps, goblets, and similar articles have been made by first pressing the foot, then blowing the head or body upon it, placing the foot in suitable bearings to connect the two together. The upper part may either be blown in a mold or previously shaped with tools and made to adhere while the glass is hot. Goblets are also made by first pressing the bowl and stem, inverting the goblet, then pressing the foot upon the stem. When the pieces are rotated in the mold the foot is placed upon a pivoted rotating form.

Molding lamps and goblets.

Pieces which are wider at top than bottom cannot be pressed in the usual way, since the plunger is always a cone, which must be pushed into the mold and withdrawn. These pieces are pressed bottom up, and lips or projections sufficient to form the bottom are formed in the mold. The piece, after being pressed, is withdrawn from the mold, the bottom is heated, and with a tool the lips are brought together to close it up.

Molding taper articles.

Pieces requiring to have designs pressed in the side which would prevent them from coming out of a mold made in one piece, have been made by having sliding lateral pieces placed in the side of the mold. These pieces are moved forward and withdrawn by suitable means, leaving the piece free to come out of the mold. Improvements in the same order have also been made for molding handles or

Molding articles with lateral designs.

Molding handles.

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Mechanical tools. Glass-presses. forming holes in handles by means of sliding pieces, which are pushed through the side of the mold and withdrawn to take the pieces out.

Molding articles with lateral protuberances. When articles are so shaped on the outside as to present a few protuberances, and it is not thought advisable to open the mold, in order to avoid mold-marks the molds are so combined that the protuberances are made by sliding lateral pieces, which, when withdrawn, allow the object to be taken out of the mold.

Mouth-shaping tools. In shaping tools for mouths of bottles, jars, etc., we have several combinations to produce effects not to be obtained by hand.

Neck-shaping tool. The ordinary neck-shaping tool for making bottle necks is made of a central pivoted piece to form the inside of the neck and two stationary pieces to form the outside. Some-

Internal-screw necks. times the necks of certain jars require to have a screw shape molded in the inside. To accomplish this the central piece of the shaping tool is made screw-like, and the two outside rubbing pieces of the desired shape, according to the style

Necks with lugs. of jar. It is sometimes desired to form cavities or projections in or on the necks of jars; this is usually done by having laterally moving pieces attached to the inside former or the outside jaws, as the case may be; these sliding pieces are operated when the tool is at rest after shaping the neck. In the same order of tools may be classed the

Pouring lips. formers for making the pouring lips on the neck of cruets. These tools have suitably shaped jaws, which are pressed

Pierced necks and covers. against the neck to give it the proper slant. It is also desirable sometimes to make holes in the side of a jar or a jar cover. This is done by having metallic pegs placed on the outside jaws, which are pushed in through the metal to pierce it. The middle piece fitting the inside of the bottle neck in some of the forming tools is so made that at the time of entering it is very narrow, but is gradually widened by forcing apart the two sections of which it is made.

Molasses cans. Molasses cans are now made with a glass pouring lip at top and slanting channel to run the dripped molasses into the can again, the whole being closed by a metallic cover. To form the glass lip the piece is molded upside down, with bottom flaps to close up the can. In this position the can forms a cone; the plunger can therefore be pushed in and withdrawn with facility. The bottom of the mold is made of a suitable shape, and the plunger is so combined with the bottom piece that the opening in the mouth of the can is made at the same time as the body is pressed. This is accomplished by the combination of a movable bottom

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with sharp angles, so that when the plunger passes the sharp angles, and fitting close against these, the bottom piece of glass is cut off as the mold bottom recedes. By this device clock frames, decanters, pipes open at both ends, etc., are also made. *Mechanical tools.* Glass presses.

Handles have been pressed in separate molds and the body of the object subsequently blown upon them in another mold, the operation cementing the two together while the metal is hot. Small hand lamps have been blown in ordinary iron molds, and the handle formed by allowing hot plastic glass to descend in a channel at the side of the mold until the two ends meet the bowl of the lamp and become cemented to it while hot. Handles. Lamps with handles.

Lamps have been made with the foot and bowl fastened together by means of a metallic ferrule screwed over the two parts. In order to obtain the screw-pegs at the bottom of the lamp bowl and the top of the foot, molds have been devised so as to give to the bottom piece of the mold a rotary motion to withdraw it from the formed peg. This style of forming screws is to avoid the mold-marks which are made when the mold opens, but, in my opinion, it is complicating the mold to obtain but a slight advantage. Lamp bodies and feet with screw coupling.

In telegraph insulators, however, requiring a hollow screw, the rotating retreating bottom piece becomes a necessity, as the plunger cannot be pushed and withdrawn owing to the projecting screw threads. Insulators

Lamps are blown with metallic pegs or collars embedded in the glass. The pegs are previously heated, set into recesses in the molds, and the lamp blown over it. I do not think this a very good improvement, for the rate of expansion of iron or metal is so different from that of glass that it frequently happens that this inequality causes the glass to crack. Lamps with metallic pegs or collars.

Round glass balls used for casters or for shooting at are now made by using molds containing several sections, which leave only a small connection of glass between each ball. A rod of hot glass is prepared, then rolled lengthwise over the different sections of the mold; the glass is gradually shaped into several balls, slightly attached together by thin connections; these are easily severed, and the balls are then perfectly round. Balls.

Glass chandeliers in imitation of their costlier brothers in cut glass are now pressed and molded at a very low cost. To press these chandeliers iron molds of the proper shape are used, and the plunger is as usual made of corresponding shape. To make the holes for the mounting pipes and the Chandeliers

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Mechanical tools. Glass-presses.

gas cocks the plunger carries lengthened pegs which fit closely into corresponding holes in the mold, and as the plunger descends the holes are cut out. These chandeliers are also blown instead of pressed. The blowing molds are of iron, properly shaped; the pieces are blown as usual, with a blow-over piece, which is detached by any of the well-known ways. This style of chandeliers consists of a series of blown or pressed pieces, which are mounted on metallic gas pipes and fastened at the ends. It will readily be seen that this mode of manufacture cheapens the cost very materially.

Chandeliers.

Movable-bottom molds.

Molds have been made with movable bottoms to allow the surplus glass, when in excess, to force the latter down, thereby increasing the thickness of the bottom piece. In order to equalize the distribution of heat in iron molds, they have been so made that by varying the thickness of the different parts the cooling and heating become equalized.

Battery jars.

To manufacture battery jars, having tubular formations running from top to bottom, a ring plate is used, having two mandrels attached to it and falling into suitable recesses in the bottom of the mold. This ring plate being adjusted in the mold, the plunger is made to come down, and by its pressure the hot glass is made to run around the mandrels while the jar itself is being formed. The plunger having been withdrawn, the mandrel plate is pulled out, and the tubular cavities now appear properly formed.

Molds for flaring articles.

Articles wider at the bottom than at the top, on the outside may be pressed by introducing between the outer shell of the mold and the plunger a cylinder tapering wider from top to bottom. The inside of the article must of course be made tapering downward towards the center, so that the plunger may be withdrawn. It will be understood that the plunger having been withdrawn, the article being wider at the bottom than at the top, it cannot yet be taken out of the mold. To do so the intermediate cylinder is withdrawn, and the article is now left perfectly free to come out.

Molding articles with bulging bodies.

A combination mold has been made to press molasses cans and such articles which are wider in the middle than at both ends. It is plain to be seen that to make such cans no plunger can be used to press the article all the way down on account of the belly of the can. To obviate this inconvenience, molds have been made of several pieces, as follows: The upper part of the can, consisting of the neck and handle, is pressed in a mold having a movable bottom piece which is run up past the belly of the can, but only to a proper distance, so that the bottom may be left thick enough

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to furnish sufficient material to form the body of the can. The plunger is provided with air passages to admit of the body being blown. The lower part of the mold, through which the bottom piece ascends, is made of the proper shape to form the body and bottom. The operation is as follows: The mold-bottom piece is run up to its proper height, glass is introduced in the mold, the plunger is brought down, thereby forming the neck and handle of the can and a thick glass bottom. The mold bottom-piece is now lowered, the thick glass bottom is dilated and made to fit the lower mold by the pressure of the air sent through the plunger, thereby finishing the piece.

Mechanical tools. Glass-presses. Molding articles with bulging bodies.

Another mode of manufacturing molasses cans consists in pressing the neck and handle in a separate mold, making the inside of the neck slightly tapering upwards. The body of the can is then blown in the usual form of mold, and the two parts are cemented by running the neck piece of the body into the pressed neck, and cement is then poured into the space left between the two.

Molasses cans.

In order to facilitate the molding of plain blown articles, molds are mounted on revolving platforms, and, by a suitable combination of levers, are made to open and shut, even when the platform is revolving. The molds may be made of a series of rollers shaped so as to make the desired article, or of sections of molds, or two solid halves. The mechanism for revolving the mold-bearer may be cog-wheels or other gearing.

Molding plain blown articles.

It is sometimes desirable to make certain articles with openings, such as on the top of a lamp head, to leave an opening for filling the lamp. These holes, or openings, are produced as follows: After the lamp head has been properly shaped, a small quantity of hot glass is dropped upon the lamp top, which has been previously reheated. The lump and the top of the lamp being now sufficiently plastic, a tool somewhat in the style of those for forming bottle necks is used. This tool consists of an annular piece, which is brought over the hot lump of glass and shapes the outside. While this annular piece is in contact, a central pin is pushed forward and pierces the glass, thus producing the opening. Should it be wanted to cement a cap over the opening, the shaping tool is provided with two levers having ends properly shaped for the purpose. These ends are pressed on the outside of the tube and form recesses.

Molding articles with openings.

Many articles, after being molded, pressed, or blown, require to be held by the foot for fire-polishing, or giving them the final shape. It has been customary, heretofore, to fix the

Spring snaps for fire-polishing.

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Mechanical tools.

foot to a piece of hot glass on the end of an iron rod, and the finishing is then put on. To detach the pieces it is necessary to part the two by giving a sharp blow on the iron rod. The foot frequently retains pieces of broken glass, which must be removed by grinding. To avoid this, spring "snaps" are used. These consist of a couple of jaws mounted on springs, so that they can open and shut. These jaws are fastened at the end of an iron rod, like a blow-pipe.

Spring snaps.

If a goblet is to be finished, the operation is as follows: The jaws are made to open, and, by the action of the springs, they immediately close upon the foot and hold the goblet ready to be finished. Sometimes these jaws are so arranged that they can be set forward and back and fastened by screws. This admits of holding a large variety of pieces of different sizes.

Cooling heated molds by air-blast.

When pressing glass continuously for a long time, the molds often get heated too high, and in this state glass is very apt to stick to them. This inconvenience is now done away with by a system of blowing air into the molds. By means of a revolving fan, or other device, and tin pipes arranged around the furnace, a continuous stream of air is furnished. India-rubber pipes are attached to the tin pipes at suitable places. By means of these pipes, after each pressing, or as often as necessary, a stream of air is sent inside of the mold, thereby cooling it. The air circulating in the pipes may also be used for ventilation and cooling the glass-house.

Application of steam to glass pressing.

Of late, attempts have been made to use presses for pressing glass by steam or compressed air. One of these presses has a set of molds carried upon a revolving bed, and is operated by a presser like a hand-press. The power, however, is applied to the presser by means of an auxiliary steam-engine, which is continually at work. Whenever an article is to be pressed, by suitable leverage the presser is forced down, then released, the bed-plate revolves far enough to bring another mold under the presser, and the operation is repeated as often as desired. Mechanism is attached and operated also by steam so as to push the pieces out of the mold after they are pressed. These are the principal features of the invention.

Application of compressed air.

In the other press steam is replaced by compressed air contained in a reservoir, which may be filled by means of an air-compressing engine. The bed-plate carrying the molds has a rectilinear motion. When an article is to be pressed, the mold is brought under the presser; by means of suitable valves and pipes, air is sent to a cylinder piston carrying the

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plunger. The pressure of the air forces the presser down into the mold, the valves are reversed, and the piston and presser fly back. A new mold is now under the plunger. The operation may be repeated as often as desired by simply opening and closing the air valves. In this press, as in the other, the pieces are forced out of the molds by rising plugs or bottoms. The different motions of this press are entirely automatic, with the exception of operating the air valves.

Mechanical tools. Compressed air. Glass-press.

In order to form the air bubbles which are often seen inside of solid pieces of glass, they have been pressed with cavities on the outside, and after being reheated they are closed by pressing the outside down with suitable tools, thus inclosing the air in the cavities.

Inclosed air bubbles.

In making chimneys many ingenious devices are now used. They are blown in metallic molds, having piercers attached to the bottom to open the lower part of the chimney. Sometimes, in order to have the chimneys cut at the proper height, creasers or cutters are added at suitable places in the mold, which, by rotating the piece, indent it sufficiently so that the superfluous parts may be broken off. Molds have been made with a base terminating in a very sharp angle. When the glass enters the mold the blower allows the glass to reach into the angular cavity, gently blows, and, when finishing, increases the force of his blowing, thereby spreading the glass at the bottom of the chimney against the thin, sharp base into a very thin sheet of glass, which can subsequently be taken off very easily. Chimneys are pressed in molds having knife-edges inserted at the bottom, thereby reducing very materially the thickness of the glass at that point. The piece remaining beyond the crease thus produced can be knocked off, leaving the chimney open at both ends.

Molds for making lamp-chimneys.

The recent tendency of work in making chimneys is to have rotating tools of different shapes, and to present the article to be shaped against it. While the tool is rotating, the different branches composing it are made to expand to a definite size after having entered the article while folded to their smallest compass. Chimneys are open at the bottom and flared at the top by means of these devices. Many devices have been used in these tools, but they nearly all operate upon the expansion principle after having entered the article. Solid conical pieces have been used for flaring, some plain and others ribbed, but they are all more or less objectionable on account of creasing or twisting the glass by the large amount of friction produced. The most

Rotating shaping tools for lamp-chimneys.

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Mechanical tools. successful flarers are those made of a few sectional branches revolving at a rapid rate.

Opening tools for cupped feet, The cupped feet of goblets are also opened by these flaring and opening tools. With the inside flaring or opening tools, jaws have been combined so as to form the outside,

And bottle mouths. both revolving. By this means the mouths of bottles are shaped, as well as the extremities of chimneys, etc. These tools are supplanting the old hand shaping tools. In order to crimp chimneys sectional blades are added to flaring tools,

Crimping tools. so that when the flaring is finished they may be crimped by pushing the blades against the flared end. These crimping tools differ in shape, but are alike in principle.

Shaping rollers. The same style of forming tools has been made with revolving rollers placed on the end of a revolving shaft. The object to be shaped is placed between the opened rollers; by suitable mechanism these rollers are made to close, the roller shaft, revolving, causes the shaping rollers to revolve by their friction against the object. By giving different shapes to the shaping rollers different styles of goods may be made. The rollers have for object to avoid the great friction produced by solid or sectional molds, and are of the same nature as the revolving molds previously mentioned.

General remarks on growth of invention in this line. I have thus rapidly sketched the principal improvements made in mechanical tools for working glass. Many minor inventions have been made, but they are mostly modifications of other devices. Our aptitude to adapt machinery to our wants is as noticeable in glass-making as in other branches of industry. Many inventors, however, not being sufficiently acquainted with the peculiar properties of glass, have applied to its working combinations of machinery altogether impracticable. Glass, while hot, may be com-

Conduct. of glass. pared to plastic dough, and it is only in this state that it can be properly worked. Should it be too hot, it becomes too liquid and cannot be worked. In pressing, the plastic mass is forced up and fills the cavity between the plunger and the inner shell of the mold. Should the glass be too liquid it could not retain the shape given to it by the mold, and would fall down again. Should the mass be too cold the action of the plunger would be hard and imperfect, and the friction of the glass against the surfaces of the mold and plunger would cause wrinkles to appear upon the face of the pressed articles. Glass being worked in a plastic state, in order to get even and smooth surfaces abrupt angles should be avoided, since the plastic mass cannot pass a sharp curve without creasing its surface. In blowing articles, shaping with tools, or blowing in molds, should the

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glass be too hot it cannot retain its shape; should it be too cold the shaping becomes difficult. Pieces requiring some time to finish them have to be reheated again and again until finished. This frequent reheating and cooling has a tendency to produce devitrification, and the glass loses its transparency.

America the pioneer in glass-pressing.

Having been the pioneers in pressing glass, we retain to this day the supremacy in this branch. European pressed glass cannot be compared with our productions, and, at the rate that mechanical inventions are applied to its working, we certainly should maintain our position over all other parts of the world. As in other branches of manufacture, patents have been issued for inventions possessing no novelties, and have led to litigations both costly and vexatious. With the custom in vogue in making appointments in our civil service this can scarcely be avoided. If examiners in our Patent Office were retained during good behavior, and not subject to political changes or removal to make places for new-found friends, we could reasonably hope to have an efficient corps, in which each man would be thoroughly posted in his own particular branch. With efficient examiners, holding their positions for life or during good behavior, there would be no inducement to do wrong, nor would patents be granted for inventions known to other persons better posted than themselves. A patent issued under the seal of the Patent Office and granted after examination by such a corps of clerks would be invaluable to inventors, and in many instances such a document would be a sufficient guarantee against the invasion of their rights. Whether we shall ever reach such a happy result in our civil service is for the people to decide. In a popular form of government what the people wish should be granted by our legislatures. The patent laws have done much towards fostering our industries, and inventors, as a class, have contributed much to our prosperity, besides pouring a large revenue into our national Treasury; they, therefore, would seem to have a right to ask the paternal care of the government.

Patents.

Qualifications for examiners in Patent Office.

Patents should be so carefully granted as to command respect.

Influence of the patent system in our prosperity.

CHARLES COLNÉ,

Assistant Secretary to the U. S. Commissioners.

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FORESTRY.

F. P. BAKER.

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[Extract from the Official Classification.]

CLASS 44.—PRODUCTS OF THE CULTIVATION OF FORESTS AND OF THE TRADES APPERTAINING THERETO.

Specimens of different kinds of forest trees.

Wood for cabinet work, for fire-wood, and for building. Timber for ship-building; staves; cleft-timber shingles.

Cork: bark for textile purposes. Tanning, coloring, odoriferous, and resinous substances.

Products obtained from forests: charcoal and dried wood; raw potash; turnery; basket-work; straw work; wooden shoes, etc.

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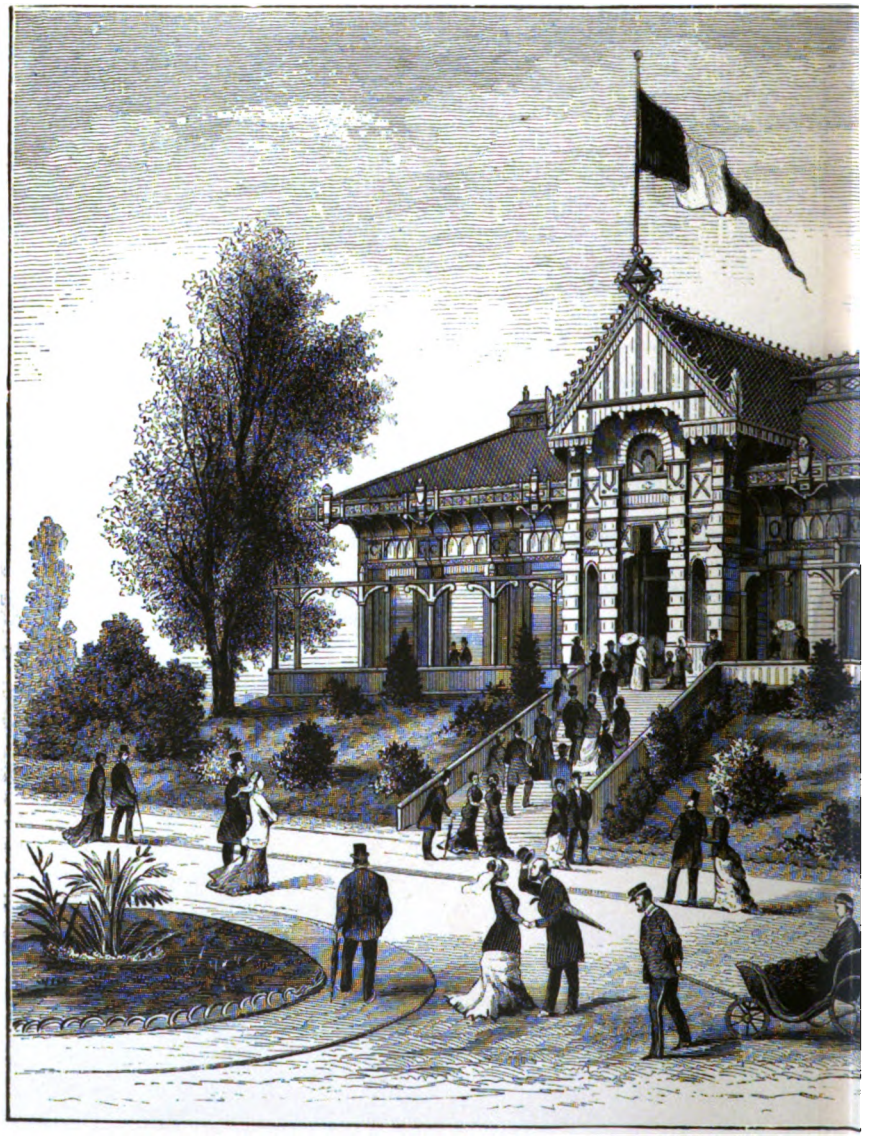

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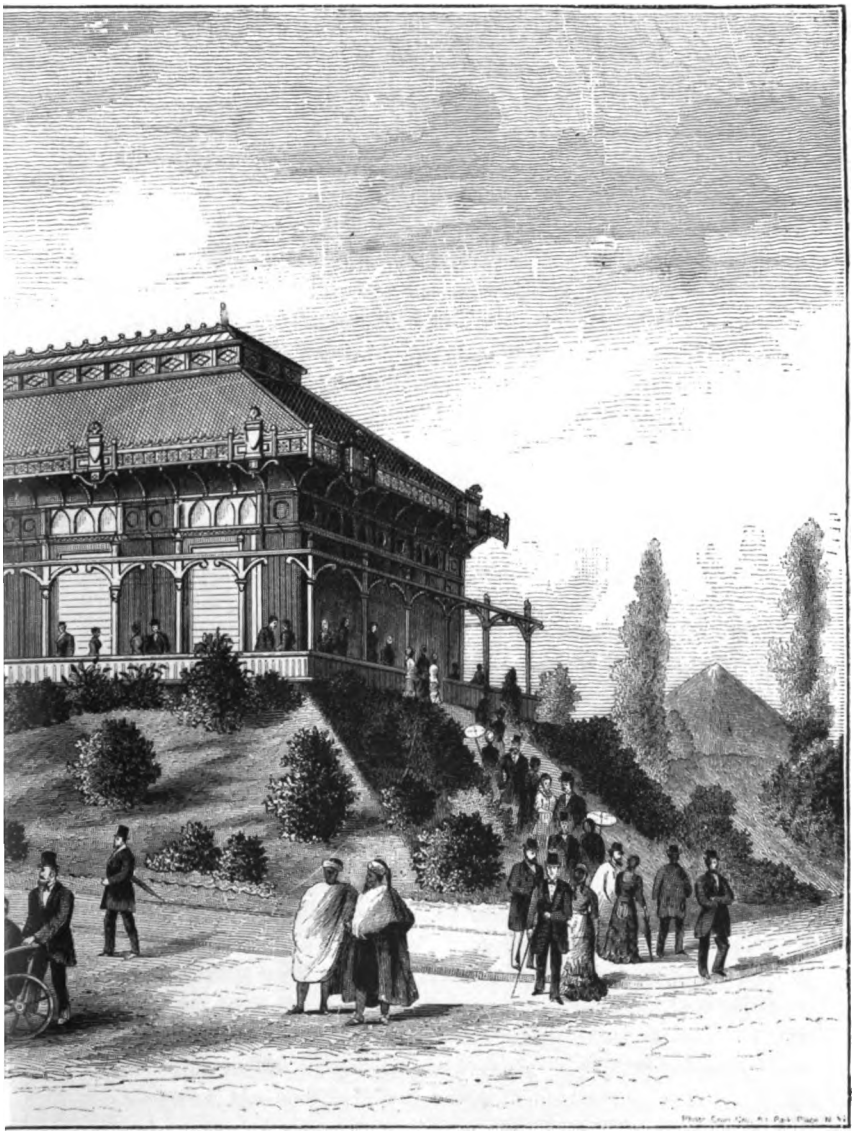

OF FORESTS, ON THE TROCADÉRO.

n, see page 392.)

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REPORT

ON

FORESTRY.

Doubtless an exhaustive, and possibly an interesting, report might be made of the features of the exhibition of forest products, implements of forestry, etc., made at Paris; but, in the understanding of the writer, such is not the object of these reports, but rather to lay before the people of the United States, in a concise form, the general information derived from an examination of the products and processes exhibited; to deal with causes rather than effects; and to give an idea of the systems by which, in European countries, under difficulties unknown in America, the science of forestry has been fostered, protected, and well-nigh perfected, and the magnificent exhibition at Paris made a possibility.

Object of the report.

Restricted thus to one view of the question, the reporter is farther hampered by the reflection that already the whole subject has been ably treated by writers who have brought to bear upon it the resources of immense observation and profound scholarship. The labors of the Hon. George P. Marsh in his "Earth as Modified by Human Action;" of the Hon. F. B. Hough in his reports to the Commissioner of Agriculture; and of that veteran in this department, Dr. John A. Warder, one of the Commissioners at the Vienna Exposition of 1873, to say nothing of scores of other writers, have left little to be said. If, under such circumstances, the present writer can bring down the history of forestry in Europe to a later period, can speak somewhat of hitherto unrecorded progress, and, what is far more important, impress upon the people of the United States the vital importance of the subject of forestry, he will have achieved his object, and have accomplished all that can be reasonably expected of him.

Geo. P. Marsh.

F. B. Hough.

Dr. John A. Warder.

In this connection he may say that it is not so much the value of forest culture as its practicability upon which the people of the United States need information. The time

American interest in forest preservation.

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has happily passed, it is to be hoped, when, throughout the United States, trees are considered incumbrances of the soil, to be got rid of by the most wasteful and destructive methods possible. There is now as much anxiety felt for the reforesting of our bare hillsides as once was felt for stripping them of the last vestige of covering. Yet, when our people consider the area thus deforested, and in addition the vast prairies of Kansas and other Western States, themselves treeless, and creating in the course of settlement a demand for the destruction of countless acres of the fine forests of Wisconsin, Michigan, and Minnesota, the American, unacquainted with any system of forest culture, unaccustomed to any State or Federal legislation on the subject, is apt to exclaim, "Who is sufficient for these things?"

Interest in reforesting denuded tracts;

and foresting the plains.

De-foresting the lumber regions.

Report directed to the question of forest culture.

The object of this brief report will be to call the attention of American doubters to the ancient adage, "What man has done, man may do," and, by speaking of the progress of forest culture, inspire a hope which may lead to practical and successful effort in the United States. As to the detail as to what legislation is best for a country where the people are jealous of governmental interference, that question must be left to the statesman; and as to the proper varieties of trees, mode of culture, and the like, that can be safely left to the intelligence of our nurserymen and farmers.

I will now give an outline of the leading exhibits at Paris, leaving the seeker after further and more precise investigation to the catalogues and other publications resulting from the Exposition.

FRANCE.

FRANCE.

The most complete exhibit in Paris.

As might be naturally expected, the French exhibit was by far the largest and most complete. The displays made, not only by the government but by individuals, were unequaled elsewhere.

The governmental exhibit was divided into two groups, the principal being made in the pavilion of the "Administration of Forests" at the Trocadéro.

The châlet of forestry.

The Châlet, (see the frontispiece of this report), was built entirely of woods grown in France, at least 200 varieties being used in its construction. This building contained the geological and entomological collections made by the School of Forestry, maps, plans, photographs, and models representing the processes of reforesting mountains and of retaining the shifting surface of sand hills. On the walls was exhibited a complete collection of the

Museum, maps, models representing the foresting of the dunes and re-foresting the mountains.

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FRANCE.

implements used in forestry. An interesting feature of this exhibition was a model showing a section of a mountain. A zigzag track, constructed of logs, somewhat after the manner of the ancient "corduroy" known in this country, was represented. In the logs notches were cut, forming a continuous groove for the runners of the sleds upon which the timber was transported to the foot of the mountain.

Implements of forestry.

Timber slide.

The workmen, dressed in the peculiar costume of the country, were represented carefully running the loaded sleds down the steep descent, while others were toiling up the mountain with the sleds on their backs, to be again loaded and forwarded on the wooden way to the foot of the declivity. To make the scene more life-like, the natural features of mountain scenery, the yawning ravines, and plunging water-courses were represented.

Model of mountain with laborers in costume.

Another view of the mountain showed the plantations of trees of various growths, and near by were shown the bleak mountain sides, as yet untouched by the labors of the forester. A statement was affixed showing the length of time required to transform the seemingly bare rocks to the thrifty woodland. Other portions of the model exhibited the massive and costly stone embankment built to prevent the soil on the slopes of the mountains from being washed into the valleys below. These structures form a prominent feature of the landscape in the mountainous portions of France and Italy, where every foot of earth is carefully preserved and patiently and laboriously cultivated.

and plantations of various growths.

Embankments for preserving forest soil in ravines.

The exhibition at the Châlet was not confined entirely to the products of processes of forestry, for in connection with them were shown the quadrupeds and birds of France, beautiful specimens of taxidermy, and also a magnificent entomological collection.

Quadrupeds, birds.

Taxidermy.

Entomological collection.

Around the Châlet were planted over two hundred varieties of resinous trees, some already successfully grown in France, others in process of acclimatization. The drawing given includes the latter plantation.

Arboretum of 200 varieties of resinous trees.

Near the Châlet, which might be termed the headquarters of the "Administration of Forests," was a small building called the "Pavillon des Gardes." It was constructed of oak logs, separated by a lattice of birch and chestnut. In this building were exhibited the collection of seeds and cones from the domain of Barres; also the tools employed in that forest establishment, and models and plans of the cheese factories which have been introduced by the Department of Forests at different points in the Alps and Pyrenees. In this connection may be noted the attention

Pavillon des Gardes.

Log and lattice building.

Collection of seeds and implements.

Model of cheese factory.

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FRANCE.

paid by the French Government to the development of the mountain departments. One of the great resources of France

Forests of the Jura and Savoy.

is the forests of Norway pine found in the high regions of the Jura and of Savoy. The wood is used extensively in the construction of musical instruments, for which purpose it is said to equal the wood obtained from the Black Forest and the Tyrol, which at present furnish the principal supply. The Exposition furnished an opportunity, which the "Administration of Forests" amply improved, of displaying the resources of France in this direction—a new channel for French skill and industry.

Exhibit in the main building.

Beside the exhibition at the Trocadéro, brief mention at least should be made of the fine display made in the main building in the *Champ de Mars*. Here were two rooms, each of them 50 feet square, completely filled with the contributions of firms and individuals, and also of the "Administration of Forests." Here were specimens of ornamental work in wood, revealing in perfection the exquisite taste and skill of French artisans. There were specimens of woods capable of receiving the highest degree of polish. Cork was shown in great variety, in its natural state and prepared for use. Great tanks for holding wine formed part of the exhibit.

Ornamental wood-work.

Collection of woods and cork.

Wine vats.

FRENCH COLONIES.

Exhibits of the French colonies.

In the main building the French colonies exhibited precious woods, the display from Algeria being especially fine. Not only from Algeria, but from French Guiana, Martinique, Guadeloupe, Senegal, Gaboon, Cochin-China, Oceanica, and New Caledonia were exhibitions on a magnificent scale.

UNITED STATES.

THE UNITED STATES.

Department of Agriculture.

The exhibits of the botanical division of the Department of Agriculture, at Washington, consisted of wood sections

Forest trees of the United States.

of the principal forest trees of the United States, of botanical specimens of the foliage and flowers, and of specimens of the larger dry fruits, as nuts and cones. The wood sections were each 1 foot in length, and embraced one quarter of a cross-section of a tree, showing the bark and the grain of the wood; each specimen was numbered, and had the name and locality painted in conspicuous type across the face of the section. The collection embraced about 300 species; of these there were 25 species of pines, 15 species of firs and spruces, and 20 species of larches, yews, junipers, and other conifers; there were 10 species of poplars and

Collection of 300 species of woods.

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UNITED STATES.

willows, 8 species of birches and alders, 28 species of oaks, 9 species of hickories, 4 species of walnuts, 9 species of elms and celtis, 8 species of ash, 9 species of maples—together with magnolias, bass-woods, locusts, cherries, etc.

Exhibit of woods.

An interesting feature of the collection of the Agricultural Department was a set of photographs of the principal trees, to show their size in proportion to that of other trees adjacent to them in the forest. The States of West Virginia, Georgia, and Tennessee were also represented in the collections of woods.

Photographs of trees.

That from West Virginia was very fine, consisting of specimens showing bark, split section, and planed and varnished section—about 300 specimens in all.

West Virginia collection of 300 species of woods.

But Oregon outdid all other sections of our country (of course excepting the exhibit of the Agricultural Department), for Oregon made the only "State exhibit" at Paris. The articles shown were all placed on a cabinet made of 25,000 pieces of wood, all from the forests of that State. The cabinet itself was a real work of architectural art. It was but 17 feet high and 9 feet in diameter at the base, running to a point at the top. The woods used in its construction included black walnut, ash, cedar, curled maple, mountain mahogany, alder, ebony, and other varieties of fine wood.

Oregon exhibit.

Cabinet of the woods of the State.

B. P. Clapp & Co., of Pawtucket, R. I., had an exhibit showing the products of dry distillation of wood, including charcoal.

B. P. Clapp & Co.; products of dry distillation of wood.

J. S. Young & Co., of Hanover, Pa., contributed a series of specimens illustrating the manufacture of flavorine and the various grades sent to the market.

J. S. Young & Co.

Thomas Meehan, of Germantown, Pa., exhibited a collection of forest-tree seeds, which consisted of about 300 specimens of seeds, all labeled with their names.

Thomas Meehan, forest-tree seeds.

OTHER EXHIBITING COUNTRIES.

Other countries.

Norway had a very creditable exhibit. The forest extent of that country is about 64,000 square kilometers—one-half belonging to the State and the other half to private individuals, who have the privilege of cultivating them as they see fit.

Norway.

Sweden had but 14 entries, but under each of these there was a large number of articles. Further on in this report reference is made to the forests and peat of that country.

Sweden.

Japan had but 5 entries.

Japan.

China had 12 entries, all by the custom-houses at different ports.

China.

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Spain. Spain had 95 entries and a fine display. At least half of the entries were by municipalities.

Austria, Hungary, Italy, etc. Austria, Hungary, Italy—in fact, nearly every country of Europe—had grand displays of the products of the forests, not only in the woods of the several countries, but in manufactured articles.

Germany. Germany, alone of the nations of Europe, exhibited nothing in any department except in that of the arts.

British Islands and colonies. England, Ireland, and Scotland had but a meager display of woods, but the deficiency was made up by the colonies of Great Britain.

Canada. Australia. Canada and the different colonies of Australia had exhibits far in advance of any other countries, with the exception of France.

Forestal legislation and statistics.

FORESTAL LEGISLATION AND STATISTICS.

In order to further show the interest taken in the subject of forestry in several countries, I purpose giving such information as I was able to procure touching the extent of forests, the traffic in the products of forests, and the laws and regulations bearing upon the subject of preserving them and reforesting the districts made bare from various causes. The information is taken for the most part from reports made to the several governments and printed in their Official Catalogues of the Paris Exposition.

FRANCE.

FRANCE.

It is instructive, as well as curious, to trace through the history of France, since the time of its occupation by the Romans, the laws on the subject of forestry.

Historic sketch. At the time when France was occupied by the Romans the country was in nearly the situation of the region now covered by the United States during the first 300 to 400 years of its occupancy by Europeans. It was then that uprooting and clearing the land of timber was carried on in order to produce cereals and to provide for sanitary interests. It was about the year 800 A. D. when the first steps were taken to protect the forests from destruction; but it was as late as 1280 before an ordinance was passed to control this subject and officers were appointed to enforce it. This ordinance and the orders enforcing it were from time to time modified and enlarged, but continued without much change down to 1669. In that year Louis XIV issued an ordinance rearranging preceding laws and making new ones. Its preamble clearly indicates that its design was to cause the general interest, which was menaced by the destruction

Forest conservancy in A. D. 800.

Ordinance of 1280.

Ordinance of 1669.

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Forestal legislation.

of forests, to prevail over the often opposed interests of the communes, of the civil or religious communities, and even of private persons.

Scope of the ordinance of 1669.

The corps charged with the application of this celebrated ordinance, and constituted by it, extended its jurisdiction not only to the estates of the royal domain, but also to those of communes, convents, and civil and religious corporations. Every mortmain, in a word, was administered by masterships, and the woods of private persons themselves were subjected to restrictions judged indispensable to assure their preservation. The hunt, fishing, and in fact everything pertaining to the administration of forests were also confided to the vigilance of officers of the masterships. The difficulties which the parliaments opposed to the registering of the ordinance of 1669 proves how much authority it conferred upon the King's officers, and how much it injured the privileges of the nobles and religious corporations; but the royal power energetically maintained its right of protecting the great social interests; and, moreover, being sustained by the public opinion, which was already powerful, it overcame the interested resistances offered by several parliaments. This superior right of protecting forests, whose preservation has from all time been recognized as necessary to the existence of civilized society, has been claimed by all governments which have succeeded ancient monarchy in France.

Estates, private and in mortmain.

Hunting and fishing regulations.

Conflict of national and vested interests.

Reorganization in 1791.

This ordinance, with various modifications, remained in force until 1791, when there was a complete reorganization. At that time, by a special decree, the number of officers was fixed at 35 conservators and 303 instructors. But it was not until 1801 that this law was put into practical operation. At that time the salaries of the officers were as follows:

Officers of administration.

	Francs.
Administrators	10,000
Conservators	5,000
Inspectors	3,500
Under-inspectors	2,000
Principal guards	1,200
Private guards	500

Salaries.

Decree of 1801.

The decree of January 26, 1801, divided the woods and forests of the republic into 27 conservations.

The first acts of the new administration were to begin the regeneration of the forest property, which was seconded in a very energetic manner by the tribunals. This, like all former laws, has been changed as necessity seemed to require, until at the present time the head of the Forest Department is one of the principal bureaus of the government.

Bureau of the Forest Department.

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FRANCE.

There are forestry schools of a high order, where pupils are trained in all the sciences, as much as those in military academies. The students graduated from these schools are bound to serve as foresters, as much as are those from military and naval schools required to serve in the army and navy. There is discipline and penalty as there is in the army, and it is as much a profession to be a forester as to be an army officer.

Forestry schools.

Administration of Forests; its scope and value.

A recent French writer on this subject says:

"It remains for us now to say what the past induces us to predict for the future. Every one has been able, indeed, to see that the forest corps, gradually separating itself from the traditions of ancient governments, has finished by taking its place beside the great public services, directed by the scientific skill and industry which characterize our age. Since the law of July 28, 1860, the Administration of Forests has ceased to be a simple financial administration. The part it plays at present is not simply to increase by a few millions the receipts of the treasury. To augment the public wealth by the development of forest cultivation, to furnish the marine, agriculture, and industry with ever-growing resources; to protect, against the combined influences of atmosphere and water, the soil and all the riches that human work and labor have thus accumulated, to increase its fertility by a wise application of forces of organic nature—such is the high mission leagued by the past to the forest corps and the latter has been for a long time in a condition to fulfill it."

Penalties for trespass.

As a matter of curiosity, and to show how important the preservation of the forests is considered, I append a table showing the penalties for injuring trees. I take this from the laws and regulations at present in force. It will be seen that the penalties vary according to the class of trees injured. The first class is composed of oaks, beeches, yoke-elms, elms, ashes, maples, pines, firs, larches, chest nuts, lote-trees, walnuts, service or quick trees, and other fruit trees; the second class, of alders, birches, aspens, poplars, willows, and other species not comprised in the first class.

Classification of trees.

Graded penalties.

Penalties for cutting or carrying away "with aggravating circumstances" apply to cases where the offense has been committed in the night-time, or with a saw, or by a delinquent who has been guilty of the same before, or if the offense has been committed with the aid of a saw by a delinquent who has been guilty of the same offense before.

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Table of penalties for cutting or carrying away trees from the public woods.

TREES OF THE FIRST CLASS.

Circumference.	Simple offense. By day. Minimum fine, by the decimeter.	Simple offense. By day. Maximum fine, by the decimeter.	Simple offense. By day. Imprisonment.	Offense with aggravation. By day—with a saw; second offense; with saw, second offense. At night—with a saw; second offense; with saw, second offense. Fine, by the decimeter.	Offense with aggravation. Imprisonment.	Observations.
m. c.	*f. c.*	*f. c.*		*f. c.*		
10	0 00	0 00		0 00		
20	1 00	2 00		4 00		
30	1 10	3 30		6 60		
40	1 20	4 80	Imprisonment 5 days at most.	9 60	Imprisonment 5 days or more.	For trees above two meters in circumference the penalties are fixed according to the same ratio.
50	1 30	6 50		13 00		
60	1 40	8 40		16 40		
70	1 50	10 50		21 00		
80	1 60	12 80		25 60		
90	1 70	15 30		30 60		
1 00	1 80	18 00		36 00		
1 10	1 90	20 90		41 80		
1 20	2 00	24 00		48 00		The fractions of a decimeter are not computed in fixing the penalty.
1 30	2 10	27 30		54 60		
1 40	2 20	30 80	Imprisonment 2 months at most.	61 60	Imprisonment 2 months or more	
1 50	2 30	35 50		69 00		The fines can only be doubled.
1 60	2 40	38 40		76 80		
1 70	2 50	42 50		85 00		
1 80	2 60	46 80		93 60		
1 90	2 70	51 30		102 60		
2 00	2 80	56 00		112 00		

TREES OF THE SECOND CLASS.

10	0 00	0 00		0 00		
20	50	1 00		2 00		
30	55	1 65		3 30	Imprisonment 5 days at the most.	
40	60	2 40		4 80		
50	65	3 25		6 50		
60	70	4 20		8 40		
75	75	5 25	Imprisonment 5 days at most.	10 50		
80	80	6 40		12 80		
90	85	7 65		15 30		
1 00	90	9 00		18 00		
1 10	95	10 45		20 90		
1 20	1 00	12 00		24 00		
1 30	1 05	13 65		27 30	Imprisonment 2 months at the most.	The same as with trees of the first class.
1 40	1 10	15 40		30 80		
1 50	1 15	17 25		34 50		
1 60	1 20	19 20	Imprisonment 2 months at the most.	38 40		
1 70	1 25	21 25		42 50		
1 80	1 30	23 40		46 80		
0 90	1 35	25 65		51 30		
2 00	1 40	28 00		56 00		

Value of forests.

FRANCE.

Value of forests.

Under this head I append the following facts and figures, which may be instructive as showing the extent of the forest industry in France, an industry which may be said to be, to a large extent, an artificial one, the result of legislation and human foresight:

Area of forests.

The woods or forests in France cover an area of 9,187,304

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FRANCE.

Area of forests.

hectares,* of which 967,018 belong to the state, 2,090,788 belong to communes or parishes and to public institutions, and 6,129,398 to private parties.

Production of forests.

The annual production of these forests is 20,000,000 cubic meters,† of which 2,500,000 cubic meters are used for building and working purposes and 17,500,000 cubic meters for fuel. In proportion as the rates of transportation decrease, and as the facilities of supply become developed, the consumption of wood in France increases progressively, in spite of the coal, which is coming more and more into general use as fuel, and in spite of the tendency to substitute iron for wood in civil and naval constructions. The annual consumption in France is, (1) of wood used in building and for industrial purposes, about 9,410,000 cubic meters, distributed in the following manner:

Consumption of wood.

Table.

	Cubic meters.
Marine, military, and merchant	70,000
Artillery engineering	40,000
Railways	200,000
Buildings	1,200,000
Clapboards, laths, etc	3,900,000
Wheelwright, furniture, and utensils	4,000,000
Total	9,410,000

(2) wood for fuel, 16,000,000 steres,‡ and carbonized wood, about 6,000,000 steres. The home production is far from supplying the demand created by such a consumption. The annual deficit is nearly 11,411,000 cubic meters, which is covered by the following importations:

Deficit of domestic productions.

Importations.

	Francs.
Fuel to the value of	2,365,000
Railroad supplies	2,080,000
Building material	125,360,000
Waste	376,000
Cleaving purposes	2,686,000
Props (especially in mines)	1,140,000
Clapboards and shingles	62,414,000
Wicker work	187,000
Corks	2,940,000
Mixed purposes	2,884,000
Total	202,432,000

Value of imports.

The value of imports during the year 1877 amounted to 203,919,000 fr., while in the year 1868 it was but 177,381,000 fr., and in 1855 only 70,000,000 fr.

* The *hectare* is equivalent to 2 acres 1 rood and 35 perches.

† The cubic *meter* is equivalent to 35 cubic feet 547 cubic inches.

‡ The equivalent of the *stere* in cubic feet is 35.3174.

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FRANCE.

It is to Sweden, Norway, Germany, Italy, and Belgium that France pays this ever-increasing tribute.

Foreign sources of supply.

The exports, which from 1855 to 1867 amounted to from 9,000,000 to 31,000,000 fr., have remained since then about stationary. In 1877 they did not exceed 44,000,000 fr.

Exports of wood.

Cork.

Cork.—As the cork-oak, or, as it is more commonly called, the cork tree, can be successfully cultivated in many portions of the United States, I give a few statistics on the subject, so far as it relates to France, referring the reader to Hough and other writers for further information.

Habitat of the cork tree.

This tree is found principally in Algiers, in Corsica, in Spain, and in Southern France. When from twelve to fifteen years of age, the tree furnishes coarse cork from which buoys are made, and which, when burned in closed vessels, affords us the Spanish-black used in painting. The cork from the older tree, which is afterwards collected every nine or ten years, is firmer, more homogeneous, and is used in the manufacture of stoppers, planks, and a thousand other objects which are fabricated, especially in Spain, and of which Seville is the chief depot. The manufacture of corks in France occupies the population of about forty parishes; among others, the Garde Freinet and Collobrières, in the *Var*, Megin and Barbast, in the *Lot-et-Garonne*. Formerly, corks were made exclusively by hand; a workman made, at the most, 1,200 or 1,500 a day. Now, owing to the use of machinery, the production has increased and reached from 4,000 to 6,000 a day for each workman, according to the sizes required by the trade. During the past twenty years the consumption has been steadily and rapidly augmenting; thus, in the year 1855, the value of imports was about 257,000 fr., while in 1865 it amounted to 2,502,000 fr., and in 1876 it reached the sum total of 2,940,000 fr. During the same period the exports were, respectively, 160,000 fr., 1,237,000 fr., and 570,000 fr. When business is most dull, Paris alone receives 800,000 kilograms* of corks yearly, representing a value of more than 3,000,000 fr.

Mode of gathering.

Manufacture of corks.

Consumption of corks.

Importation.

Consumption of Paris.

ITALY.

ITALY.

The Direction of Agriculture, to which was joined the forest service, with the intention of presenting a sufficiently complete proof of the forest resources, made several collections, which are properly illustrated in the official table,

* The *kilogram* is equivalent to 2 lbs. 3 ozs. 4.428 dms., avoirdupois weight, and 2 lbs. 8 ozs. 3 dms. 2 grs., troy weight.

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ITALY.

forming part of the table of agriculture, expressly published for the Universal Exposition of Paris.

Exhibit of wood, wood extracts, and small objects in wood made by the mountaineers.

These collections consist (1) of a collection of horizontal sections of trunks belonging to the principal trees of Italy which furnish wood for civil and naval building and for working; (2) of another collection, reduced to the smallest specimens, of all the woody species vegetating in the kingdom; (3) of a collection of resinous, fibrous, coloring, and tanning materials; finally, (4) of a collection of little objects in worked wood, executed by the inhabitants of the Alps and Apennines.

Statistics of imports and exports.

In the statistics of imports and exports from January to December, 1877, it is found that the exportation of the raw building material, together with that but little worked, amounted to the value of 2,373,277 fr., while the imports of the same material during the same period amounted to the value of 44,024.095 fr. In the preceding year, 1876, the difference between the two figures was somewhat less, the amount of imports being valued at 37,295,000 fr., and the value of the exports 3,136,050 fr.

Cabinet-making and veneer woods.

The importation of wood for cabinetmaking and veneering amounted, in the year 1876, to 9,706 quintals, and in the following year to 9,397 quintals; while, for the same years, the exportation amounted, respectively, to 450 and 174 quintals. There remains to be added to this amount the stocks

Gun-stocks.

of guns roughly hewed from the walnut tree, which are specially treated in the custom-house tariff, and of which there was an exportation, in the year 1876, of 4,032 pieces, and in the succeeding year of 2,314. The importation of

Dimension timber.

wood sawed lengthwise—for laths, rafters, small joists, etc.—presents a notable prevalence over the exportation. An ex-

Wheelwrights' timber.

ception should be made in favor of wood for the wheelwright—quarter-pieces, spokes, carriage poles, axles, etc.—which, during the last two years, had no importation whatever, while the exportation amounted to 3,321 quintals in 1876, and 2,822 in 1877.

Oak and chestnut staves and clapboards.

The abundance and luxuriance of oak (*Quercus cerris, Linn.*) and chestnut trees, which grow so strongly and rapidly in Italy, favor the manufacturer of staves and clapboards, which, in a small degree, are also prepared with another oak, the *Quercus sessilifolia (Smith)*.

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ITALY.

The following abstract shows the movement of the commerce of Italy in this material for the two years 1876 and 1877:

Statistics of commerce in wood.

Importation, in hectometers.		Exportation, in hectometers.	
1876.	1877.	1876.	1877.
17,739	15,082	101,033	92,890

The following abstract shows the commercial movement in relation to fuel, both wood and charcoal, in the years 1876 and 1877:

Wood and charcoal.

Fuel.	Importation, in hectometers.		Exportation, in hectometers.	
	1876.	1877.	1876.	1877.
Charcoal	14,328	11,386	49,608	60,603
Fire-wood	72,218	72,029	7,072	6,431

Tanning bark.

The traffic in tree-bark for tanning leather exists, to some extent, but in this department Italy is entirely dependent upon other countries.

Resinous products.

Moreover, it may be necessary to mention the resinous products which have no special industry, although there are not wanting suitable trees—as the *Pinus laricio*, the *Pinus excelsa*, and, finally, the *Larix europœa*—which, during a certain period, provided in Italy the turpentine that, in commerce, took its name from Venice, where this traffic was principally carried on.

Potash.

Again, the potash trade, which was at one time so flourishing in Italy, and especially in the ancient Neapolitan state and in Tuscany, is to-day gradually losing its importance, since there has been found a way of drawing a better profit from woody material of whatever kind.

Cork.

The bark of the cork tree, a very common plant in the continent of Italy on the borders of the Mediterranean, and very abundant in the island of Sardinia, is not so elastic nor of such fine texture as that which grows in more southern climes, yet it occasions quite an active commerce. There were exported 8,261 quintals of native and worked cork in the year 1876; the importation of the corresponding material was, in the first year, 6,069, and in the second 2,321 quintals.

Production of wood.

The production of growths of whatever kind, owing to the numerous rivers and torrents which traverse the Italian soil and that of the adjacent islands, without speaking of the extensive wet lands and marshes which abound, attains each

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ITALY.

year a higher figure. Of this production, the chief part serves in the interior for the fabrication of vessels destined for the gathering of grapes and fruits, either to be sent abroad or from one place to another of the interior, for vegetable or orchard products, or for the use of the wine-press, distillery, or cellar. Another part is directly exported, as the following figures prove:

Production of wood.

	Importation.		Exportation.	
	1876.	1877.	1876.	1877.
Small growths of whatever kind...quintals....	1,973	1,675	4,916	4,923

SWEDEN.

SWEDEN.

The report of the Swedish Commissioner to the Paris Exposition contained a vast amount of information on the subject under discussion. I have space for but a few items. The report says that the several catalogues of public forests show the following divisions at the end of 1876:

Division of wooded domain.

	Hectares.
State parks	1,843,600
State property in moving sands	2,200
State surplus territory and grounds not bounded	1,344,300
State forest domains and property farmed for the state	49,100
Forests of the state ceded to functionaries, to ecclesiastical authorities, and others	530,900
Forest domains belonging to different administrations and institutions	35,000
Forest land given over to sawing mills	244,100
Forest land given over with subsidy treaty to works	28,000
Forest lands in districts and common woods	172,000
Forest land belonging to the state and those given over for clearing	971,500
Total	5,221,500

Value of domains

The value of the three first categories of forests (3,190,000 hectares) being brought in the accounts of the state for the sums of 32,163,000 crowns ($8,934,000) only, this moderate estimation clearly shows that the forest riches of the state are not overrated in any way.

Extent of wooded domain.

The extent of the forests placed under the immediate administration of the state increase year by year by the purchase of private forests (for 221,530 crowns in 1876), or by the separation of forests from farmed state lands. In the year in question, 1876, the public forests gave a gross receipt of 1,093,479 crowns; after a deduction of 618,549 crowns for the expenses of the administration; the revenue

Yearly income.

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which entered the public treasury during the same year amounted in consequence to 474,930 crowns, the highest figure given during a long number of years.

Administration.

The forests of the domain are placed under the surveillance of the Administration of Forests (*Skogsstyrulsen*), under the jurisdiction of the Minister of Finance, and under the direct care of employés and agents of the forest service. The latter is composed of 9 district inspectors, 88 inspectors of small districts and 75 supernumeraries for this same category, and 595 forest guards and other inferior agents. Besides this force committed to the administration and surveillance of the public forests, the state pays 6 engineers, who, for a moderate sum, assist private proprietors desiring to submit their forests to a regulated economy.

Districts and inspection.

Royal Forest Institute.

With a view to spread abroad a more general knowledge of forest science, and more particularly to render foresters more skillful, there was founded, in 1828, a high forest-school, the Royal Forest Institute (*Skogsinstitutet*), situated immediately at the gates of Stockholm, in the Royal Park, which serves as a field of application for the pupils. This institute is governed by a director, who is at the same time a first professor of forest economy. He is assisted in his educational duties by 5 other professors in the departments here designated: (1) a professor of forest economy; (2) a professor of national history; (3) a professor of chemistry and physics; (4) a professor of forest legislation and administration; and (5) a professor of politicol economy.

Founded in 1828.

Professors.

Course.

The academic course of two years is divided into two divisions; the summer months—July, August, and September—are spent in practical exercise, such as forest surveying, the appraisment of forests, the manufacture of charcoal, etc.

Requisites for admission.

Whoever desires to enter as a pupil must be of a strong and sufficiently mature constitution, must enjoy good health, and must have practiced at least a year with a forest employer. At present the institute counts 40 pupils, of whom 11 are Norwegians and 3 Finnish.

Subvention.

The institute receives yearly 21,300 crowns. Moreover, the director has the right to take and employ, for the benefit of the school, the proceeds derived from the sale of plants and the young wood of nurseries; also 50 crowns paid by each foreign pupil, as well as the sums received for forest maps executed by the pupils. These revenues amount, on the average, to 3,000 crowns yearly.

Income.

Forest schools

To form good forest guards the state has founded 6 forest schools in suitable localities throughout the country. The theoretical instruction is given in these institutions by the

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SWEDEN.

director, who is, at the same time, chief of the forest district in which the school is placed. Practical instruction is confided to an undermaster, and for this post are chosen such persons as have passed with distinction through a forest school. In each one of these schools, where the instruction is of eight months, 10 pupils receive, besides a free instruction, lodging and a pecuniary grant which about suffices for their keeping.

Forest schools.

The economy of private forests is submitted to no administration control.

Forests supply the fuel for the metallurgical works.

Sweden depends almost exclusively upon its forests for the fuel necessary for its metallurgic industry. The manufacture of charcoal also takes place upon a large scale in the greater number of its provinces, but chiefly, as it is hardly necessary to say, in the great mining regions, all belonging to the central part of the country. It is evident that the situation of Northern Sweden necessitates a great consumption of wood for fuel, and also that its immense forest wealth is such as to inspire no idea of economy in this respect. For these reasons the consumption of wood for fuel is truly prodigious, even if the agricultural population have become less wasteful. Moreover, except in the great cities and in some parts of the territory, as well as in the entire province of Leanie, wood is always employed as the material of construction in nearly all the houses and out-houses of Sweden, and it is declared to be the custom to build too many and too large edifices. This is also a great cause for the diminution of the forests. Then come the fuel necessary for industrial establishments, wood for working, for building ships and small craft, but especially the truly unheard of quantities of young wood which is required for fencing; the wood is sawed and placed obliquely in the ground, and the pieces are tied with hemlock or osier twigs. The fences not only separate large tracts, but divide different grounds of agricultural cultivation, whether among themselves or to separate them from public or private roads. So much for the internal consumption. If to these be added the immense exportation, it may be admitted that at the present time the following figures represent the total of forest cultivation in Sweden:

Great domestic consumption of wood for fuel,

for building,

for shipbuilding,

for fencing.

Statistics of consumption.

	Cubic feet.
Wood for fuel	891,000,000
Wood for working	110,000,000
Wood for exportation	200,000,000
Total	1,200,000,000

which is more than 31,000,000 cubic meters.

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SWEDEN.

If all the other little sources of profit be taken into consideration, the annual revenue of the Swedish forests, in round numbers, may be estimated at 165,000,000 crowns ($45,800,000). Revenue derived from forests.

The exportation of wood during the last few years has shown a marked tendency to increase principally in joists and boards, while that of the second principal articles, beams and stop-posts, has remained about stationary, as the following statement proves: Exportation of timber.

Years.	Stop-posts.	Joists and boards.
	Cubic feet.	*Cubic feet.*
1865	*16,000,000	58,173,000
1870	15,203,000	77,378,000
1875	14,518,000	82,118,000
1876	17,502,000	96,792,000
1877	16,796,000	105,427,000

The total exportation of forest products for the year 1876 was: Exportation of forest products.

		Quantity.	Cubic feet.
Beams and stop-posts	pieces	483,100	9,945,700
Beams and stop-posts, large size	do	1,440,009	7,556,100
Timber, masts, yards	do	504,400	0,547,600
Sleepers	do	465,500	274,600
Pit-props	do	10,693,600	10,268,900
Boards and joists	dozen	5,346,800	96,792,000
Board ends			5,333,700
Lath-wood			590,109
Lath	pieces	568,700	
Wood for fuel			2,604,100
Hoops, etc	pieces	125,500	
Wood for oars	do	36,300	
Staves of beach	do	27,102,200	
Staves of oak	do	1,058,600	
Rough wood	do	149,900	
Worked wood	do	3,327,100	
Resin, common	quintals	147,900	
Resin, superior	do	2,600	
Lamp-black	do	324,900	
Bark			316,200

The total of this exportation amounts, as indicated in cubic measure, to 140,000,000 cubic feet. If there be added to this figure other articles of exportation, taking into consideration the waste resulting from the cultivation, the whole amount may be estimated at 200,000,000 cubic feet, in round numbers—that is, 5,000,000 cubic meters—the total amount of wood exported from Sweden at the present time.

Peat.

Peat.

As there are beds of peat in the United States, and it is a subject about which our people know but little, I give entire the report which I find in the Swedish catalogue on this subject. That the peat which is known to exist in our

*Approximately.

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SWEDEN.

country must soon be made available is evident. I know of large areas of this article in Western Kansas, in regions where there is no timber or coal. In that portion of Kansas, which is now being rapidly settled, the settlers depend in a great measure for fuel on buffalo and cattle "chips," hay, corn, etc. In the immediate vicinity of these settlers are thousands of acres of peat. It only needs knowledge how to prepare it economically to bring it into immediate use. The Swedish report says:

Peat.

Swedish report on peat.

"The results of explorations made up to the present time permit us to state that the marshes occupy one-twelfth of the whole surface of Sweden, and that the peat of these marshes has an average thickness of about two meters. If we burned only peat, the peaty marshes would then be more than sufficient for our needs. Until a very recent period peat has been extracted in greater or less quantities only in the regions of Bohnslan and of Leanie. For the past fifteen years the utilization of this fuel has made a marked progress in other provinces, owing to the rise in the price of coal, and also to the zeal of several parties, who, by speaking and by writing, have called the attention of the public to the existing necessity for our country to draw profit from the immense natural wealth existing in our peaty marshes. The chief merit in this regard is due to the General Director of the Survey Bureau, M. L. B. Falkman, who spread abroad the knowledge of the peat traffic by means of two pamphlets, published with the aid of the government, upon the peat bogs of Sweden. The result was the rapid development of this interest, which soon arose to the importance of an industry.

Extent of peat marshes.

M. L. B. Falkman.

Exploration.

"Owing to the activity manifested by many private persons, the peat bogs have been explored in detail, and an appropriate method of working fixed for each one of them. The iron company (*Jernkontoret*) becoming interested in the question, in the year 1875 engaged persons to examine these bogs, and to aid their proprietors in the establishment of maps and plans to explore them.

"Moreover, several societies, from time to time, have taken identical measures. Except the aid given by Mr. Falkman by the pamphlets already alluded to, the state has done nothing to favor the examination and utilization of peat, whether by granting salaries to persons capable of giving instructions in this branch or by recommending the use of peat as fuel in its establishments.

Suggested use on railways.

"There is, however, every reason to hope that mixed and freight trains will use it. The preparation of peat is liable to no tax whatever, and since its production is given by no statistics at all, it is difficult to indicate even approximately the extent of its production. Private information which we have been enabled to gather throws a certain light upon one of its chief branches—that is, its mechanical preparation. In 1865 50 machines for producing peat were in operation. In the beginning of 1878 there were 450, of all sizes, made in the country, and about 20 imported. It may, therefore, be stated that in this same period the production increased eight fold. If we take 5,000 tons for the average yearly production for each machine, the mechanical preparation of peat would correspond to 700,000 toises* of hem-

Peat machinery.

Production.

* The *toise*, French linear measure, is equivalent to 6.39459 English feet.

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lock. For cut or natural formed peat we have no information whatever. SWEDEN.

"The following are the modes of working peat in Sweden: *Peat.*

"By cutting: This is done by a shovel, and the peat has the form of bricks. The cutting is operated by a right shovel provided with a wing (Bavarian system), and the operation is carried on by two workmen (Dutch system). Mode of working.

"Preparation by the so-styled *marchage*. This method, as in vogue in Hanover and Westphalia, is commonly employed in Sweden. *Marchage* is no longer done by men or horses, but by different kinds of grinding and bruising machines, of which we shall mention a single one, run by steam. This machine, of great size, is composed of a horizontal cylinder 1½ feet in diameter and 12 feet long, in which the peat is bruised by means of blades fixed upon axles turning at the rate of a hundred revolutions a minute. *Marchage* system. Grinding-machine.

"There is also a hand-machine employed, consisting simply of a hollow cylinder put in rapid revolution and pressing the peat against a fixed plate. As the bogs containing good peat generally abound in roots, layers, or stones, the peat may not be cut to advantage, but must be ground by means of a machine which works it at the same time. The following is a description of one of the machines employed in this manner: Machine for the manufacture of the cylindrical peat, constructed by M. H. S. Samuelson, consists of a kind of peat press, made chiefly of wood, with an elevator uniting the mouth of the press to that part of the bog whence the peaty substance ought to be lifted. The machine is simple or double. In the first case, it is run by a man, a horse, and five other workmen; in the second, steam and double the number of workmen are necessary. The peat is raised from the bog and thrown into the elevator; this latter carries it to the mouth of the press, which is constantly supplied with the natural peat. So, without being moistened, it is lightly crushed by the press, whence it comes out, pressed in the form of a cylinder, upon a table placed at the foot of the press to receive it. Each cylindrical block of pressed peat, with a diameter of from five to seven inches, has from one to three longitudinal holes, of an inch in diameter, to admit air to the interior and thus dry the block more rapidly. Aided by a skillful workman, a simple machine can furnish, it is said, from 2,000 to 2,500 pieces of cylindrical peat a day; a double machine from 5,000 to 7,000 pieces. In 1872 this last machine was constructed by Mr. Roos, of Norrkoping. This manufacturer furnished peat machines (cylindrical), strong, solid, and of a perfect finish, of which the sale has been so considerable that at the present time more than 200 such machines may be found in the hands of the public. The ingenious idea of Eichorn to manufacture spherical peat (*kultorf*) has received a considerable development by the efforts of Messrs. Van Horn and Thunberg. Two large factories of this peat (spherical) have been founded, one at Vargarda and the other at Vang. The stationary factories of this kind being of a very expensive construction, and the transport of the native material increasing the expenses of the manufacture, Messrs. Thunberg and Anrep, preserving the principle of Eichorn, have furnished machines for grinding peat, which are, without doubt, among the number of the best produced in any country, owing to the great improvements that Anrep has formerly made. At the present time 50 such machines are in operation in Sweden and in other countries." Hand-machine. Samuelson's cylindrical peat machine. Production. Spherical peat.

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DENMARK.

I condense the following from an article in a monthly published in Paris called the "*Revue des Eaux et des Forests*," a publication of great value, and a standard authority on the subject of which it treats, throughout all parts of Europe. I am indebted to its pages for much valuable information.

Revenue of Danish forests.

The revenue of the Danish forests may be estimated at 40 fr. a hectare, which makes a total revenue of 7,000,000. The yield of the forests of the state, which cover 38,000 hectares, is but 17 fr. a hectare; in 1861 their product was 685,000 fr. In the last century the greater part of the forests was divided among several proprietors, and burdened with taxes of every kind. The thinning out or clearing out of trees was free.

Forestal law of 1805.

A law of September, 1805, already prepared by writ of 1757, put an end to this state of things. All undivided property was to be shared before January 1, 1857; all rights of pasturage were to be taken away; and the proprietors of great domains, where the forests were heavily burdened with taxes, were authorized to free them from tax by way of modern *contenement*, but with the express condition that they should give up to the commoners only lands not wooded. All lands thus ceded ought to remain henceforth in the hands of their new proprietors, without being reunited, at a later date, to the domains, unless it be for the purposes of regrowing trees.

Preservation of existing forests.

Other dispositions of the law of 1805 prevented clearings under conditions; ordered the boundaries of forests; prescribed the preservation, under the penalty of considerable punishment, of all the full-grown forests existing at the time; and tended to propagate this mode of culture at the expense of the coppice.

Laws for conservation.

Every person who should purchase a forest was forbidden to cut it, without authorization, during the first ten years, except such wood as was necessary for his own and his farmers' consumption. A writ of December 3, 1819, added to these conservative measures a prohibition to divide any forest unless its extent reached 100 toendeland,* and its division could not be hurtful to the regrowing. The result of those dispositions was that nearly all the forests passed into the hands of the great proprietors, the establishments, and the state; the smaller proprietors preserved only lands not wooded, and commoners even today possess only insignificant tracts of wooded lands.

Coppice giving way to forest.

The coppice has given way to trees of larger growth almost everywhere. The administration is confided, as in

* The *toendeland* is equal to 55.16 acres.

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France, to the Minister of Finances. The other forests, with the exception of coppices and such large forests as have grown since 1805, are submitted to the superintendence of the government, whoever may be the proprietor. The prefects and their adjutants enforce the articles of the law of 1805 which relate to clearings, boundaries, and the division of forests, etc. It is their duty to send in every year to the minister a report upon the state of forests in their department.

State superintendence.

Cases of prosecution are in the hands of the subprefects, who in Denmark are not only functionaries of the administrative order, but who are at the same time charged with the direction of the police in their jurisdiction, and for certain affairs they even perform the part of judges of the first instance. The forest agents named to assist the prefects are generally inspectors of state forests; they are 9 in number; each is at the head of a circumscription, of which the extent is fixed by the Minister of the Interior. They must, on every occasion, lend their aid to the prefects to superintend private forests. Some of their principal functions are as follows: They fix the position and regulate the felling of trees which private individuals who have acquired forests have obtained the authorization to sell during the first ten years of their purchase. This felling of trees, authorized exceptionally by the law of 1805, is now very frequent. The forest agents must see that the possibility of the forest be not exceeded; that its production be not compromised; that the regrowth be prepared for a large growth of the forest. They are charged to see that the demands for clearing be proper.

Prosecutions.

Forest agents.

Duties.

Regulations for felling and clearing.

In Denmark the Minister of the Interior can now authorize the clearing of forests on condition that the proprietor of the part to be put into a state of cultivation shall replant, or have replanted, a piece of land of the same or of greater extent, if the wood cleared was occupied by beech and oak; and if the land to be rewooded be not suitable for the cultivation of these species (circular of May 27, 1858), the forest agents will furnish the necessary information for the furtherance of the object, the value and fertility of the soil, the state of the plantations already made, etc. They watch over the replanting of the lands ceded to small owners, in execution of the laws of 1805, and see that the large landowners reunite in their forest holdings. These reunions have been numerous. At length they have complete administration of the woods of the parish clergy, which are, however, in small quantities. These forest agents are paid by the Minister of the Interior, according to a tariff agreed

Substitution of new plantation for land disforested.

Official oversight and advice.

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DENMARK.

upon in advance. But when they are called upon to take possession of a private forest, the proprietor must reimburse the state for the salaries which are due them. In all that concerns the woods of the parish clergy, the Minister of Religion arranges their salary in advance.

Official oversight of forests.

PORTUGAL.

PORTUGAL.

The forest service of the kingdom of Portugal is divided into two distinct parts, the administration and the technical service. The administrative service comprises the general administration, book-keeping, and the direction of the pine forests of Leiria and the establishments annexed—that is, the resin manufactory—and the forest of Bussaco. The technical service is divided into the superior part and the subaltern part. The superior part is composed of the chiefs of the three forest divisions of the center, of the north, and of the south, which comprises all the national forests of the kingdom.

Administration.

Technical service.

The director of the pine forests of Leiria and 6 forest-masters form the subaltern part. The pine forests of Leiria, and the establishments annexed, constitute a special administration, under the orders of the director of Leiria.

Pine forests of Leiria.

The general administrator directs all the service; he is assisted by a secretary and an assistant secretary. The treasurer pays all authorized expenses, and deposits all receipts. The chiefs of the divisions submit each year to the general administrator the projects of management and of the works to be undertaken the following year, and give to him an account of the different operations made the preceding year. These officers are, moreover, obliged to study the forest conditions of the various regions in their respective divisions; to designate the grounds belonging to the state, to communes, to parishes, to private corporations; and to execute whatever may be prescribed. Conferences, presided over by the general administrator, are instituted for the examination of projects of management. The chiefs of the three forest divisions and the functionaries of the administrative service are called to take part in them. Such an organization seems to satisfy all the exigencies of a forest service.

General direction.

Division superintendents.

Special studies of the respective regions.

Conferences.

SPAIN.

SPAIN.

There is no country of Europe more interested in the preservation of its forests than Spain. If the burning heat of its climate be not tempered by the beneficent influence of forest vegetation, if the conditions relating to the mountain

Spain's peculiar need of forests.

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SPAIN.

rivers be not regulated by a proper distribution of trees, and if the lands which can have no other destination than the culture of trees be allowed to remain open and used as a common highway, Spain will go on decreasing in population, and becoming poorer and poorer. Nevertheless, there are few regions where forest wealth experiences such neglect. Fire, devastation, and especially a free and universal pasturage have bared the majority of the mountains. A rapid glance at the administrative measures applied to the forests called public in Spain, during the last few years, will show the extent of these forests, their resources, and their future.

The conversion of large regions into a treeless grazing ground.

A law of May 1, 1855, prescribed alienation of woods by mortmain, excepting from the sale of such forests as were deemed by the government to be useful for the public interest. A royal decree of October 26, 1855, divided the public forest into three categories: (1) forests excepted from sale as being submitted to the forest rule; (2) forests whose alienability is uncertain; (3) forests susceptible of being immediately exposed for sale. The first category comprises the forests of pine, hemlock, oak, ash, chestnut, juniper, and all those species judged by forest engineers to be useful, on account of their altitude, to maintain the wooded state. The second category comprises forests of cork, green oak, and trees occupying generally the middle regions. The third category includes the forests of willows, beeches, alders, etc., situated in the plains, and which may be cut down without inconvenience.

Law of 1855.

Categorical division of forests.

The classification of forests by the nature of species was easy, and consequently it was accepted. But the uncertainty which prevailed relative to the forests of the second category provoked a new decree, dated February 27, 1856, which united this category to the third, with this restriction, that, when it was deemed essential for the public interest, forests belonging to either of the three categories might be saved from sale.

Difficulty in classification by altitude.

Decree of 1856.

A third decree, February 16, 1859, re-established the rules laid down by the decree of 1855; forests of the second category were to be classed, according to circumstances, among forests to be preserved or among those to be sold; and the government caused a table to be published, from which we extract the following remarks:

Decree of 1859.

Spain comprises 49 provinces, the total population of which is 15,050,870, divided into 46,490 parishes, containing 49,983,160 hectares. The total extent of public forests is 10,186,044 hectares, divided into 30,646 groups. There are

Area of Spain.

Forest area.

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SPAIN.

but 671,258 hectares which belong to the State; 3,427,561 hectares must be sold. There is to be maintained under the forest government the surplus of 6,758,483 hectares, in 19,774 groups, belonging as follows:

State and salable areas.

Proprietaries.

To the state, 467,566 hectares, in 3,494 groups.
To public establishments, 52,791 hectares, in 53 groups.
To parishes, 6,238,125 hectares, in 16,227 groups.

Present extent of public forests.

The operations of alienation began, no doubt, at once, for the last documents report only 6,758,483 hectares as the extent of public forests in Spain.

In making up the classification according to the decrees of 1855 and 1859, it was found that the country possessed many more forests than was supposed, but it was also brought to light that their condition was worse than had been believed. The condition of the public forests may be appreciated after considering the figures which form the budget of 1861, and which have been established after the results known of the year 1859:

Bad condition of forests.

Income and expenses of administration.

	Reals.	
The expenses of administration amounted to	9,716,506	$497,825
Of which charged to the State	2,340,440	
Of which charged to the provinces	1,912,118	
Of which charged to the parishes	5,463,948	
The products are	9,197,273	459,868
Of which for state, first	300,000	
Of which for state, second, for 100 paid by the parishes for expenses of excise and contributions	1,779,454	
For the parishes	7,117,879	
Deficit		37,957

Such a strange and unlooked-for result being brought about by the preceding decrees, a new decree was necessary. This decree was made February 22, 1862, and contains the following principal dispositions: The forests whose prevailing species are the pine, oak, and birch were exempted from the sale prescribed by the law of May 1, 1855. This exception is applicable only to forests including at least 100 hectares, be it in a single group or in several groups separated from each other by at least a kilometer. In such forests as are exempt from sale it is forbidden to cut trees, to make resin, or make any objects whatever, except what may be necessary to preserve the trees. Such sales as were made before the decree of February 22, 1862, were confirmed, but such as are not completed were broken.

Decree of 1862.

New limitations.

ALGERIA.

ALGERIA.

The recognition and the cultivation of woody territory in Algeria have necessarily followed the progress of the conquest of the soil and of its colonization. The result is that

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ALGERIA.

though an exact inventory of the forest wealth of Algeria is not yet entirely completed, it is very rapidly approaching completion. The last statistics, carefully prepared and published under the direction of the conserver of forests, in 1877, give the following figures in the three provinces:

Area of forests in 1877.

Area, in hectares, of the forests where the species prevail.

Areas of species.

Species.	Oran.	Algiers.	Constantine.	Total.
Cork tree	14,558	36,393	198,429	249,380
Zeen oak	....	....	60,548	60,548
Green oak	228,298	104,634	208,480	541,412
Pine of Aleppo	273,747	233,959	261,700	709,406
Cedar tree	....	2,138	74,411	76,549
Thuja	19,128	11,546	.....	30,674
Sea-pine	....	.....	1,524	1,524
Elm and ash, master-tree, wild olive, and locust tree	40,078	59,242	223,463	322,783
Eucalyptus (different species)	....	....	.....	.....
Total	575,800	447,912	1,028,555	2,052,276

Thus the wooded domains of Algeria contain, in round numbers, about two million hectares. Adding to this number (1) 153,865 hectares of the cork tree which have been given in full right to those persons who were grantees of the first working and cultivation, by the decree of February 2, 1870, and (2) 74,000 hectares abandoned to tribes or villages as common property, the total surface of forests at present existing in Algeria amounts to 2,280,870 hectares—that is to say, to more than two-thirds of that of France.

Public and private.

The most important products of Algerian forests are: Cork; woods for building, for timber work, for cartwright's work, cabinet-maker's work; tanning barks; and coloring materials.

Products of Algerian forests.

(1) The cork trade during the past ten years has been steadily and rapidly increasing, in spite of great fires which at different times have come to devastate certain forests. For example, the export of cork, which in 1867 was only 896 tons, of 1,000 kilograms, representing a value of a million francs, has progressively increased so as to attain, in 1876, the figure of 4,350 tons, representing a value of more than five millions of francs. The Algerian cork is remarkable for the thickness and regularity of the slabs which it furnishes; and, on account of its elasticity, hard grain, and beautiful color, it is much sought for for commerce.

Cork.

The law concerning fires, a better management of the forests, the formation of a squad of workmen properly instructed in the art of cork cultivation, and the gradual improvements of the means of transport have already given, since 1874, a new impulse to this great industry, which is

Management of cork forests.

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ALGERIA.

only, so to speak, in its beginning, and which for the present time may be regarded as a reliable source of fortune for the department of Constantine.

Zeen oak.

(2) The zeen oak, which has been already much appreciated by the Turks for the construction of ships, has been announced as peculiarly appropriate for that purpose by M. Legrand, engineer. There are at present about 18,000 full hectares of the zeen oak cultivated for ship-building purposes, cooperage, and railroad sleepers, at an average price of 55 fr. a cubic meter in the forest.

Cedar and other forest trees of value.

(3) The cedar, of which the colony possesses very fine specimens, the austral ash, the pine of Aleppo, offer the same qualities of resistance as in Italy and in Turkey; the thuja, the olive tree, the pistachio tree, the juniper tree, the lemon tree, and the holm oak furnish beautiful and excellent wood for furniture, and are each year more and more appreciated.

Eucalyptus.

(4) The eucalyptus (blue gum of Tasmania), the most useful varieties of which have been imported and made common throughout Algeria by the energetic perseverance of M. Ramel, commences to furnish products of a real industrial value. This remarkable tree, whose growth is very rapid, furnishes, from the age of ten years, a wood nearly as hard and as resistant as that of the oak, excellent for telegraph posts, railroad sleepers, cooperage, piles for both salt and fresh water, timber wood, cartwright wood, and cabinet-maker's wood.

Hygienic influences of the blue gum.

An inquiry made in 1876 by the Society of Climatology of Algiers gives as a result that more than 2,000,000 of these trees have been already planted in Algeria, and it may be considered as a fact that the influence of this tree in that colony is both hygienic and febrifuge. The leaves are employed with success in the treatment of fever and in certain typic affections; they furnish by distillation an essence which enjoys balsamic properties very worthy of being studied and applied. All the facts concerning the planting properties and products of the eucalyptus are presented and treated in the pamphlets published by MM. Ramel, Cordier, Trottier, Fillias, and in a recent work of M. Certeux, entitled, "Guide for the Planter of the Eucalyptus in Algeria." These documents were placed at the disposition of the public in the statistical section of the Algerian exhibit.

Barks.

(5) Oak barks of Algeria of different kinds, that of the eucalyptus and of certain Australian acacias, containing tannin in variable but considerable proportions, were ex-

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ALGERIA.

hibited. The cork bark is by far the richest; it is cultivated on a vast scale, and is especially bought by England and Italy; an example to be followed as a duty by France.

Export of tanning bark.

In 1867 Algeria exported 8,000 tons of tanning bark, representing a value of 1,600,000 fr. From 1873 this important traffic has increased more rapidly, as the following figures testify:

Years.	Tons exported.	Value, in francs.
1873	8,316	1,663,000
1874	10,575	2,115,000
1875	13,460	2,692,000
1876	19,046	3,809,000

Thus the average amount yearly exported, for five years, was about 13,000 tons, representing a value of 2,500,000 fr. It is constantly increasing.

PRUSSIA.

PRUSSIA.

Forest administration.

The forest administration in Prussia forms, as in France, a division of the financial administration. At its head is a general director, assisted by a council composed of 2 head masters and 2 inspectors. The business affairs are treated by general guards and pupils; they are not, however, very numerous, since the administration is less extended in Prussia than in France. The personnel of the agents of active service is composed of head masters, inspectors, and general guards. There is one head master for each department; these grand masters are divided into two classes—

Salaries.

those of the first class receiving 10,000 fr., and those of the second class 8,000 fr. Below the grand master is the inspector, who receives about 6,000 fr., and they are obliged to keep a horse. No indemnities are allowed either to inspector or grand master. After the inspector come the grand generals, and to this grade are attached the most advantages. A general guard has from 3,000 to 3,600 fr. of fixed salary, a forest house, with seven or eight hectares in gardens and meadows, and also fuel. Moreover, he has the right to hunt in his district, and pays but little for each piece of the game killed. This advantage is equal to at least 500 fr. a year. His district includes from 5,000 to 6,000 hectares of forests. They are named for life, may take part in political proceedings, can be deprived of office only by a judgment, and live an independent life. The forest agents are recommended from the Forest Academical School of Neustadt, near Berlin. The pupils enter the service in quality of general guard pupils after a sojourn of three years at school, and

Districts.

Forest Academical School of Neustadt.

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PRUSSIA.

after having passed a severe examination. They are named general foot-guards, in proportion as vacancies occur, every five or six, and even ten, years after graduating.

Forest officers.

Salaries and privileges.

The list of officers comprises, as in France, brigadiers and guards. A brigadier has 1,500 fr., a house with about three hectares, and fuel, and he may replace the general guard in all forest operations. Each brigade is composed of about 10 guards. A guard has 1,000 fr., a house with about three hectares of ground, and fuel, a sorting of from from 500 to 600 hectares in extent. The officers are recruited from the military corps of hunters. They must have served there thirteen years, but may do in reality only about three years of effective military service, and they complete their time in quality of aids to the guards. These periods vary necessarily according to the requirements of the service. The guards are named by the president of the council, at the proposition of the grand master, who delivers the commissions. They belong in general to the families of the forest guards. For agents, as for guards, the right to withdraw results from invalidity, independent of age. The pension of a retired officer is a quarter of his regular pay after having served twenty years, and a half after thirty years of service; after forty years service, six-tenths; and after fifty years the retired officer is entitled to receive three-fourths of his pay when in active service. The parish guards are paid by the parishes, about 1 fr. 25 c. a hectare. When a parish has forests of a certain importance, it is obliged to take its guards from the corps of workmen.

RUSSIA.

RUSSIA.

This empire is not behind others in schools for educating youths to become foresters. I give a detailed account of these matters, condensed from an article in the "Review of Waters and Forests."

Forest school at Lissino.

Forest school at Lissino.

This school was founded in 1834, with a view to complete the theoretical instruction. The forest belonging to the establishment was managed in 1841 to serve as a model.

Administration.

The administration of the school is confided to a director, and two experienced forest professors are charged with the instruction. This school contains a library, where all Russian and foreign works relating to forests may be found.

Museum.

It contains also an herbarium; a collection of species of trees and shrubs, with their seeds; a collection of machine

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models; apparatus and instruments employed in forest culture—a very remarkable technical establishment. This institution is like a little industrial village. Each building of which it is composed is a manufactory unlike every other, except the house occupied by the guardian and his family. There are to be seen: (1) a manufactory of essence of turpentine; (2) a manufactory of potash; (3) a manufactory of birch pitch; (4) a manufactory of pitch of resinous trees; (5) a manufactory of lamp-black; (6) a chemical laboratory; and (7) a piece of ground reserved for the carbonization of wood in piles of Oural. The occupations at Lissino are divided, according to the seasons, into spring, summer, autumn, and winter occupations.

Forest school at Lissino.

Laboratories and manufactories.

Spring occupations.—The course begins toward the end of April. During three or four weeks excursions are made into the forests, the professors treating all the important questions relating to forest culture, and showing the application of the rules which the pupils know only in theory. They are occupied in the nurseries and in the forest, and the floating of wood upon the neighboring rivers which empty into the Neva is studied.

Spring occupations.

Summer occupations.—When, after the spring exercises, the pupils have acquired sufficient practice to pass to the managing work, a certain extent of forest—from 100 to 200 hectares—is assigned to each one to survey and apply the rules of management. Surveying is done by means of the plane-table, the astrolabe, and the compass. Besides, each pupil is obliged to execute, under the inspection of a geometrician, the leveling of a certain portion of marshy land, and to draw up a project for rendering it salubrious.

Summer occupations.

Autumn occupations.—After the works of the forest management, the pupils are occupied with artificial restocking, either by seed plats or by plantation. All experiments already made at Lissino of this nature are passed in review, and the professors explain the success or the failure, making mention of the circumstances which have accompanied these experiments. The manufacture of charcoal is studied, as well as that of tar, essence of turpentine, and other forest products, under the direction of an experienced workman.

Autumn occupations.

Winter occupations.—The pupils, to whom parts of the contiguous forests have fallen, form companies, and each company makes an official report upon the works of management of its part, considered as a forest apart. Compositions are written upon given themes. The professors make a critical analysis of new works published in relation to forest economy. The pupils are also occupied in studying the quite

Winter occupations.

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RUSSIA.

complicated science of book-keeping. The course at Lissino is terminated by an examination, after which all the pupils are classed in four categories, as follows: (1) Second lieutenants; (2) ensigns; (3) employés of the fourteenth class; (4) geometricians. To encourage work, prizes are given for the best compositions. These prizes consist of gold medals—1 large one of the value of 600 fr. and 1 small one valued at 200 fr. All pupils who receive instruction in these schools at the expense of the Ministry of Domains are required to serve this ministry for a period of five years; for the others the term is reduced to two. The young men begin their service by entering for two years the commissions for managing forests. After this, those of the first and second categories are placed as general guards, those of the third category as their adjutants, and those of the last remain always geometricians. Those thus installed as general guards may be promoted without any examination whatever. Nevertheless, to form superior agents of administration, as well as professors for the numerous schools, the government has judged it useful to create a special course for officers. This course was created in 1840.

Forest school at Lissino.

Examinations.

Prizes.

Course for officers.

Course for officers.—To this course are admitted forest agents of the first and second categories, whether immediately after serving in managing forests or later, but always after an examination which confirms their aptitude for independent work and a certain proof of intellectual ability. The course lasts eight months, and comprises the following studies: The literature of forest sciences, comparative history of forest law, political economy in relation to the state, statistics, climatology, geology, analytical chemistry. Those who distinguish themselves in this course acquire the right to occupy immediately the position of inspector of forests, or that of chief of a commission for managing a forest.

Course of the externes.

Course of the externes.

I have already said that the forest institute is on the point of being suppressed, experience having brought to light two principal faults in its organization—its great expense, more than 700,000 fr. a year, and the insufficiency of the results. Indeed, a young man scarcely fifteen years of age is hardly capable of choosing his true and proper vocation, and he often recognizes it only when it is too late. To remedy these inconveniences, to some extent, the administration has profited by the general movement which has occurred in all the Russian special and military schools. It has opened a course for young men who have finished their

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studies of natural sciences, and who consequently have to study only the properly styled forest sciences. The course, called "Course of the Externes," is divided into two parts: (1) the theoretical instruction, given during eight months by professors of the forest institute; (2) the practical exercises, which continue for the same length of time, and take place at Lissino.

Forest school at Lissino.

Course of the externes.

Inferior forest schools.

Inferior forest schools.

The institution of guards, the essential element of all progress in the art of forestry, has acquired in Russia an importance proportionate to the extent of the forest territory. It is owing to this great extent that these inferior schools were created. Individuals of all classes are admitted, without any other condition than that of knowing how to read and write. The course is of three years, and comprises the following branches: Religion, Russian language, arithmetic, geometry, surveying, leveling, forest botany, forest culture, forest law, book-keeping, making out official reports, drawing, writing. The theory of forest science is taught only in its generalities. During the summer and autumn the pupils are engaged in working in the technical establishment, in leveling, and in surveying. Hunting and shooting with the air-gun are the chief recreations. Before leaving school the pupils are obliged to pass an examination, after which they are classed in three categories: (1) those who are very apt receive the name of forest conductors, and have a right, after twelve or twenty years of service, to the first military grade; the others become (2) brigadiers or (3) simple forest guards. Those who receive a free education are obliged to submit to ten years' service in the Ministry of Domains. The other pupils pay 400 fr. a year, and, as they devote themselves to the service of proprietors, the school delivers them diplomas of capacity.

Course.

Studies and recreations.

Examinations.

Free and pay scholars.

Schools of the Steppes.

School of the Steppes.

All the southern part of Russia, from the 50th degree, is deprived of wood. It is the region of the Steppes, vast plains very like the prairie lands of the United States. Many attempts have been made to force growth there. The government, recognizing the great advantages which must result to the country from the transformation of waste and barren plains into productive forests, has encouraged these undertakings, and directs such endeavors by the aid of practical schools of forest culture. The most important of these schools is that of Anadol, in the government of

Design to convert plains into forests.

School of Anadol.

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RUSSIA.

School of the Steppes.

Victor de Graff.

Yekatherinoslan, the founder and director of which is M. Victor de Graff, an eminent forester, known to the learned world by his extended works upon descriptive botany. He graduated in 1841 at the forest institute, made a voyage in Southern Russia, and studied all that this country presented which was peculiar, as much in relation to the soil and climate as to the economical conditions. After this expedition he was appointed to organize a school, of which the following particulars are taken from the regulations:

Course.

Requisites for admission.

The course lasts three years. The candidates must be from fifteen to seventeen years of age, of good constitution, and must know how to read and write. The instruction, food, and clothing are free for those who serve the state during ten years, and for the others the price is very moderate.

Studies.

The studies are arithmetic, the first elements of geometry, surveying, the elements of forest economy and agriculture, elementary medicine, and the veterinary art. The lessons are given by an efficient conductor of forests, or by young foresters who have followed with distinction the course of the forest institute, and who are sent by the administration for a year in this school that they may form successors of M. de Graff. Rural economy and medicine are taught by special teachers. The school possesses a good library, and an annual sum of 1,200 fr. is employed to keep it in good condition and to enlarge it. There is also a meteorological observatory. New pupils are practiced in their work under the supervision of the comrades of the preceding course.

Workshops.

Workshops of all kinds have been created, that the pupils who are obliged to work there may choose their congenial vocation. In this manner they become good workmen, and when they return to their own towns they propagate civilization.

Subventions and privileges.

Government gives to all the pupils who graduate from this school a certain amount of land and 200 fr. to enable them to undertake its management. They are also freed from all taxes for two years. The best pupils are installed as gardeners of the plantations which each village of the steppes must have, covering an area of at least four hectares. The ground and the young plants for the plantation are allowed gratuitously by the state. The original number of pupils was fixed at 40, but the affluence was so great that a change has been made, and now 100 are admitted.

Schools of Berdiansk and Meikhaillolskoe.

Similar schools have been founded at Berdiansk and at Meikhaillolskoe. It is more than probable that the number of these schools will be yet increased, since experience has plainly shown their great usefulness.

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General reflections.

In conclusion, I may say that the display of forest products made at Paris by the United States, while excellent as far as it went, was nothing compared to the display that might have been made by a country like ours, possessing 380,000,000 acres of woodland. An adequate exhibition of our resources has, in fact, never been made, and it is to be hoped that among the glories of the future will be such a display. It is safe to say that all Europe combined could never equal it.

The possible American display of forest products.

The American as a destroyer of forests.

The people of the United States have, up to a comparatively recent period, been famous destroyers of the forest. It is a significant fact that the American ax takes precedence in the markets of the world, and that the American chopper is the most expert axman. Thousands of acres of noble forest trees have been destroyed merely to rid the earth of them. The Western pioneer has passed his life in the toilsome labor of chopping and burning trees which his descendants would gladly replace.

Public sentiment in favor of conservancy of forests.

Of late years a growing public sentiment has sprung up in favor of the preservation and cultivation of trees both for ornament and use. The evils of forest destruction are now generally admitted, though our practice is not always in conformity with our theory. So general is the belief, however, in the theory, that I have not deemed it necessary to enter into the discussion.

How shall we repair the waste of the past?

The practical question remains: What can we do to preserve and restore our forests, to repair the waste of the past, and provide for the needs of the future?

Governmental interference a failure.

Governmental interference is a resource to be used sparingly, for the simple reason that it is not, as a rule, efficacious. There has existed for many years a statute against cutting timber on government lands, and it is safe to say that few statutes have been more persistently violated. In newly settled sections few people see anything wrong in cutting government timber. In fact, there is a sort of belief that, as the timber is used in the development of the country, in house-building, and the like, the public is rather benefited than otherwise by the operation, and that no one should complain. Where such a sentiment exists it is idle to expect the authorities to be vigilant in the enforcement of the law.

General opinion of new settlers.

Timber-culture act more effectual.

The timber-culture act has been more effectual than repressive legislation. In this act the government holds out substantial inducements for the cultivation of trees, becomes the patron and encourager of forestry, and thus fosters a popular sentiment in favor of tree-growing. Doubtless, the

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General reflections.

law might be made better; but the safer course is, it seems to me, not to make new laws or amend old ones, but to enforce the act already on the statute-book. If a rigid compliance with the law as it now stands is exacted, the results will, doubtless, be more satisfactory than a host of minute regulations, such as are suited to the genius of European countries, but would prove irksome and thus inoperative here.

Enforcement of our protective statutes.

Voluntary effort.

"Arbor Day" in the West.

It is safe to say that voluntary effort has done more good than legislation, either repressive or protective. The device of an annual "Arbor Day," originating, I believe, in the State of Nebraska, has filled many Western cities and towns with beautiful shade trees at no cost to the government, Federal, State, or municipal. "Arbor Day" has been added to our scanty list of public holidays; young and old join in the cheerful labors of the day, and schools and religious societies are conspicuous in its observance. In one day in Topeka, the capital of Kansas, more was done toward beautifying the grounds belonging to the State, by the free and voluntary labors of its citizens, than had been done in years under the authority of the legislature and at an expense of several thousand dollars of the public money. This incident is mentioned as illustrating the real and true method of carrying out measures beneficial to the mass of the people. With us the people are everything, the government very little.

The prospective work of foresting the Western prairies.

A fair field is open in this country for the labors of the forester. It is safe to say that for many years no effort need be made to imitate the European experiments in reforesting the sides of barren and almost inaccessible mountains. The fields of labor will be the great and fertile prairies of the West, where the work will be comparatively light, rapid, and inexpensive. The fact that trees *will* grow on the prairies, west as well as east of the Mississippi, is a settled question. No well-informed person disputes it. It is no longer a matter of experiment. It only remains to push forward the good work by the means I have suggested,

The timber-culture act.

by the continuance and careful enforcement of the timber-culture act, and the fostering of a public sentiment in favor of tree-growing by the observance of "Arbor Day," and the

Fostering public sentiment in favor of tree-growing.

dissemination of information on the subject by the Department of Agriculture and the public press. At all fairs and exhibitions of natural products the development of forestry should be made much more conspicuous than heretofore.

Acknowledgement of assistance.

Finally, I desire to return my thanks to the gentlemen in charge of the French Department of Forests at the Paris

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Exposition. They were unwearied in their courtesy, and special facilities were allowed me in the way of the examination of books and documents, admission to libraries, etc.; and, in short, those officers displayed that courtesy and intelligence which have made their department a benefit to their own country and a model to others. Acknowledgements of assistance.

The forest conservancy of British India in dealing with large and, in many cases, uncultivated areas of forest and jungle, as well as tracts of treeless plains, offers to us many points of interesting study. Unscrupulous depredators upon public lands there, as here, have done damage which a century of care cannot entirely remedy. I have therefore added as an appendix a report by the Hon. George C. M. Birdwood, C. S. I., M. D., the author of the "Hand-book to the British Indian Section." Appendix, on conservancy of forests in British India, by Hon. G. C. M. Birdwood.

F. P. BAKER,
Additional Commissioner.

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"FOREST CONSERVANCY IN INDIA.

Forest conservancy.

"The forest department in India is for administrative purposes, divided into three separate establishments; the forests in the several districts immediately subject to the Government of India being under the general control of Dr. Brandis; those of the Madras Presidency under Lieut. Col. R. H. Beddome; and those in the northern and southern divisions of Bombay and in Sinde being under Mr. A. T. Shuttleworth, Lieut. Col. W. Peyton, and Mr. J. McLeod Campbell, respectively.

Administration.

Territorial divisions.

"Forest conservancy in India dates from the year 1862, when Dr. Brandis, then conservator of forests in Burmah, was appointed inspector-general of forests by the Government of India, and the various isolated establishments which had been formed in Burmah, the central provinces, and Oude were consolidated under him. There were at this time, also, conservators in Madras and Bombay, while in the northwest provinces the special charge of the forests had been confided to the civil commissioners of Meerut and Kumaon. But these officers were rather timber agents than conservators; and though some good was effected by them in the way of regulating the felling of timber, it cannot be said that the proper work of forest conservancy was anywhere undertaken or even understood by them. Their only definite purpose was to secure a good net revenue from the operations of the department.

Dates from 1862.

Dr. Brandis.

Revenue rather than conservation the object under the previous system.

"Dr. Brandis, from the very first, took his stand on the opposite principle. He never lost an opportunity of keeping before the government and the officers of the department that the main object of forest conservancy in India is to preserve, not to cut down, the forests. At the same time he made it clear that the department could be self-supporting, and it always has been under his administration.

New departure under Dr. Brandis.

"When Dr. Brandis assumed charge of the department, the forests in the most parts of India were in a deplorable condition, and the worst part of the mischief had only been done within the previous ten years, viz, between 1850 and 1860. This happened through the unrestricted depredations of the contractors for railway sleepers. When the first railway was commenced in India, about 1850, the most exaggerated notions got abroad of the profits that were to be realized by selling sleepers to the railway companies. In consequence of this, every petty timber dealer in the neighborhood of the projected lines commenced to speculate in sleepers. Unlimited credit in liquor was given to the Gonds, Bheels, Koor Koos, Koles, Khoonds, and other indigenous tribes who inhabit the forests of the grand central plateau which extends across India from east to west between the 15° and 25° of north latitude; and before the government could become aware of it, these skillful woodmen had succeeded in felling almost every mature teak tree along the whole extent of this vast range of country. Hundreds of thousands of valuable trees were cut down which never could possibly

Deplorable condition of the forests.

Destruction of timber for railway sleepers by the indigenous Dravidian tribes of the hills and central plateau.

Slaughter of the teak trees.

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BRITISH INDIA.

Forest conservancy.

have been converted into sleepers or removed from the forests in the shape of timber. The consequence was that the annual forest fires, passing unchecked over the hills, every year consumed the felled timber little by little, and when the first conservancy officers were appointed in 1860 they found nothing but the charred remains of these logs to indicate where extensive forests had once overshadowed in perennial green the head springs of the Mahanuddy and Nerbudda.

Burning of the felled timber by forest fires. 1850–'60.

Chronic difficulties.

"Besides this special mischief which had been done during the ten years between 1850 and 1860, two great evils had always existed and tended to keep down the growth in India. These were unrestricted grazing in the forests and forest fires. The fires were caused partly by the shepherds, who burnt the grass in order to get early green crops with the first rains for their cattle, and partly by *comari* or *dhya* cultivation, which is much in favor with the wild tribes all over India and Burmah, and which consists in felling and burning portions of the forests in order to sow a crop of coarse grain in the ashes.

Unrestricted grazing.

Forest fires.

Limitations of these destructive agencies.

"Dr. Brandis's first step was to check and limit forest fires and cattle grazing. He abolished the name of forest ranger everywhere, which had previously found favor, and strongly insisted on forest officers being called forest conservators.

"Major (now Colonel) Pearson had already been appointed forest ranger in the Nerbudda provinces in 1860, and about the same time Colonel Ramsey and Mr. Williams had been appointed to the same office in Kumaon and Meerut. Dr. Claghorn (conservator of forests in Madras) was then deputed to the Punjub, to organize a forest administration for that province. This resulted in the appointment of Dr. Stewart as conservator. To this appointment succeeded that of Mr. Leeds (who was transferred from Burmah) in Bengal and of Captain Van Someren to Mysore, while Major Pearson's charge in the Nerbudda district was extended over the Nagpoor country and the Berars. All these provinces, except Madras, Bombay, and the Northwest, were united under the supervision of Dr. Brandis, inspector-general to the Government of India.

New organization of forest conservators.

Conservancy of the whole jungle impracticable.

"It was soon found that the conservancy of all the jungle spread over the continent of India would be impracticable, partly from its vast extent and partly because a large percentage of the area was too bare and too denuded of vegetation to be capable of producing trees except at an impossible cost.

Selection of the better portion for reservation and oversight.

"The first step, therefore, taken was to divide the better portions of the forests from the inferior. This was generally done by the revenue survey, working in concert with the forest officers, who were intrusted with the selection. The central provinces set the example in this work. The better forests were marked off as 'reserved' or 'state forests,' to be managed entirely by the forest department. The remainder was divided into two portions, one of which was made over to the villages for their special use (answering to the communal forests in France), and the other was in some cases managed by the civil officers of the district, and in others by the forest department, chiefly with a view to revenue rather than forest conservancy.

Dedication of the remainder to the villages and to revenue purposes.

"The first attempt to keep down the annual forest fires was made in the central provinces. This was carried out by Captain Doveton, under the orders of Colonel Pearson. The Bori forest, at the southwest angle of the Puchmurri Hills, was selected for the experiment. It is not far from the Sohagpoor station on the Great Indian Peninsular Railway. The forest has an area of about 25 square miles or 16,000 acres.

The Bori forest the theater of the first experiment.

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Forest conservancy.

It is isolated by a broad line cut all around it, and divided also by fire lines, after the system pursued by the French forest department in the south of France and in Algiers. The experiment was perfectly successful. A few extra hands put on during the dry season, who patrolled the lines, and could collect speedily at any threatened points, sufficed to keep fires out of the reserves. Except a few isolated patches, this forest has not burned since 1863. The beneficial effects of this plan of operations have been more marked than was even anticipated, for the long rank grass which formerly grew in the forest, and which was the great cause of danger from its inflammability, has everywhere been replaced by a shorter and finer grass which burns much less readily; while a rich vegetable mold is gradually being formed on the hard-burnt crust of earth which formerly existed; and in consequence there is everywhere throughout these forests a sufficient crop of young seedlings springing up. The success obtained in Bori has led to the extension of the system, and fire conservancy is now one of the chief duties of forest officers in India. At the same time cattle have been gradually excluded from the reserves, and, with few exceptions, grazing is permitted in the unreserved forests only. Caution was required in at first enforcing this restriction, as in some provinces serious injury might have been done to cattle-breeding had the usual grazing grounds been closed before others were provided.

Success in the restriction of forest fires.

Replacement of jungle grass by herbage.

Increase of seedling trees.

Limitations of grazing privileges.

"It was necessary, however, that the proceedings of the forest department should be legalized, and with this view a forest act was passed by the legislative council in 1865. On this act, which was confessedly imperfect and insufficient, were based the forest rules drawn up for each province. These also were in all cases preliminary; and a more comprehensive act, entitled 'The Indian forest act, 1878,' received the assent of the governor-general in March, 1878, and has now consequently become law. Its operations are, in the first instance, limited to the territories respectively administered by the governor of Bombay in council, the lieutenant-governors in the northwestern provinces and the Punjab (except the district of Hazara), and the chief commissioners of Oude, the central provinces, and Assam. Any other local government may, however, from time to time, with the previous sanction of the governor-general in council, extend this act to all or any of the territories for the time being under its administration, by notification in the local official gazette.

Forest act of 1865.

Act of 1878.

Territory included in the operations.

Assistance by local governments.

"In 1868 the northwest province forests were placed under the Government of India. The next step taken was to organize a forest survey department, with a view of insuring uniformity in the forest maps and for training officers in surveying. Captain Bailey, R. E., was appointed to the charge of this branch, which it is now proposed to enlarge, and attach to it a forest school for the training of native forest subordinates, to be established in the Dehra Doon.

The northwest provinces.

Forest school of Dehra Doon.

"The appointment and training of forest officers has always been a matter of the greatest anxiety to all who have had to do with the control of the department, for the future of forest conservancy in India must depend largely on the spirit of working and the principles handed down by the earlier generations of officers to their successors.

Training of forest officers.

"In this matter it is impossible to pay too high a tribute to the practical wisdom and foresight displayed by Dr. Brandis. This officer saw at once that the only road to success lay in the appointment to the department of officers who knew what forestry meant. With this view, so far back as 1867, he, with the sanction of the Secretary of

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BRITISH INDIA.

Forest conservancy.

State, entered into an arrangement with the French and German Governments with a view to the training of a certain number of young men in the regular forest schools of those countries for the Indian service. Since that date about fifty officers have passed into the department, who have received a scientific forest training, and now nearly half the establishment in India, and among them several deputy conservators, may be reckoned as specially educated men, ranking, and in most cases keeping up intimate relations, with the forest officers of France and Germany. Since 1875, with a view to the better supervision of the young men, Colonel Pearson has been appointed to their charge, and all the pupils are collected in the French school at Nancy, where five or six are sent annually for training.

Training of officers in French and German forest schools.

Col. Pearson.

French Forest School at Nancy.

M. Mathieu.

"The first idea of forming a collection of Indian timber and forest specimens for the Paris Exposition originated with M. Mathieu, subdirector of the Forest School at Nancy, who has formed the valuable museum at that school. The Indian Government warmly approved the idea, and it was taken up at once by Dr. Brandis, the inspector-general, to whose unremitting exertions the very perfect collection offered to the inspection of the world at Paris was completed and dispatched from India in time for the opening of the Exposition. He was ably supported by Messrs. Gamble. Smythess, and other old pupils of the Nancy school, and it was proposed that the collection should be presented, after the close of the Exposition, to the school, for the use of the English pupils, as well as a token of recognition of the benefits that the forest department have received from it.

Collection of Indian forest products at Exposition presented to Forest School of Nancy.

Introduction and dissemination of valuable trees.

"Besides the conservation of existing forests and the formation of artificial forests which were required in the interest of the public, the forest department is instrumental in the introduction into different districts of new classes of trees, valuable either on account of their timber, fruit, or other produce, such as teak, sâl, sissu, caoutchouc, cinchona, etc. The cultivation of lac is also encouraged, while the important question of fibers suitable for paper stock or other manufacturing purposes has recently engaged a considerable amount of attention.

Area of demarkated forests in 1877:

of plantations;

of protected forests.

"The area of natural demarkated reserved forests under the Government of India at the close of the year 1876–'77 amounted to 17,421 square miles; that of unreserved forests is not accurately known. The area of plantations or artificial forests amounted to 24,683 acres, or over 38 square miles; and that protected from fire during the dry season of the year was 2,850 square miles, or over 16 per cent. of the entire reserves. During the year 5,008 persons were charged with forest offenses and prosecuted, of whom 3,817 were convicted and 1,191 acquitted. The total receipts of the forest department amounted in 1876–'77 to 498,452*l.*, and the expenditure to 328,068*l.*, leaving a balance of revenue to the state of 170,384*l.* Of these amounts the timber sold by the department at its depots realized 252,842*l.*, the expenses incurred in its collection, etc., having been 142,075*l.*, so that this branch of the operations of the forest department realized to the government a net revenue of 110,817*l.*

Prosecution of trespassers.

Receipts and expenditures.

The Madras Presidency has but few reserves.

"In the Madras Presidency, beyond certain fuel reserves in the railway districts of Cuddapah, Salem, Trichonopoly, and Madura, and some small tracts in Palghaut and South Arcot, there are no forest tracts that can be termed strictly reserves, and no real forest from which cattle and fire can be rigorously excluded, although almost in every division there are ample tracts which might be set apart as re-

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Forest conservancy.

serves without much interference in the rights of grazing and other communal rights. The extent of fuel reserves is about 144,927 acres, or a little over 226 square miles. Land set aside for plantations aggregates 15,484 acres, of which, however, only 8,258 acres are as yet planted. The receipts of the department in 1876–'77 amounted to 41,531*l.* and the charges to 41,397*l.*, leaving a small net balance in favor of the department of 134*l.*

Receipts and expenditures of the Madras department of forests.

"Timber operations realized a sum of 18,482*l.*, at an expenditure of 9,221*l.*, thus yielding a surplus to government of 9,261*l.*

"The number of persons prosecuted for forest offenses during the year was 999, of whom 469 were convicted.

Bombay Presidency.

"The total area set apart for reserved forests in the Bombay Presidency amounts to 5,654 square miles, of which 3,754 square miles are in the northern division, 1,520 miles in the southern and 380 miles in the Sinde division. Small plantations exist in most districts of the presidency, but no regular measures have yet been adopted for the prevention of fires, which are of general occurrence in the Bombay forests. In Sinde forest fires are almost confined to the Upper Sinde forests. In this part of the presidency a system of inclosure has been introduced as a means of natural reproduction. Within the inclosed blocks, wherever the land receives moisture, either by direct flooding or percolation, a dense and vigorous growth has sprung up, and large open tracts have been thus converted into impenetrable babul thickets. The areas under production in Sinde aggregate 4,267 acres, in 1,147 acres of which artificial reproduction has been resorted to. The forest revenue for 1876–'77 amounted altogether to 122,602*l.* and the expenses 83,169*l.*, which left a surplus income of 39,433*l.* The timber operations undertaken by the department resulted in a net return of 29,838*l.*, the receipts having amounted to 62,870*l.* and the charges to 33,032*l.* The number of cases in which persons were charged with offenses against forest rules during the year was 1,520, of which 1,186 were sustained and 334 failed.

Area of reserved forests.

Forest fires almost unchecked.

Inclosures in Sinde.

"Summarizing the foregoing financial results, it appears that the total receipts of the forest department throughout India amounted in 1876–'77 to 662,585*l.* and the charges to 452,634*l.* Timber operations realized 334,244*l.*, while the expense attendant thereon amounted to 184,328*l.* The net returns to government thus amounted to 209,951*l.*, of which 149,916*l.* was derived from the sale of timber at the departmental depots.

Receipts and charges of the general forest department.

Net returns.

"It is not necessary to more than allude to the great importance of forest conservancy in its bearing on Indian famine and floods."

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COTTON CULTURE.

HON. P. M. B. YOUNG.

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[Extract from the Official Classification.]

CLASS 46.—AGRICULTURAL PRODUCTS NOT USED FOR FOOD.

Textile materials: raw cotton; flax and hemp, scutched and unscutched; textile vegetable fibers of all kinds; wool, washed or unwashed; cocoons of the silk-worm.

Various agricultural products used in manufactures, in pharmacy, and for household purposes; oleaginous plants; oil, wax, resin.

Tobacco in leaves or manufactured. German tinder. Tanning and dyeing substances.

Preserved fodder, and substances specially intended for feeding cattle.

NOTE.—The following report treats only of cotton

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REPORT

ON

COTTON CULTURE.

Exhibition of cottons not as full as might have been expected.

I found, after a careful examination, that the cottons on exhibition were not as good a representation of the cottons produced in the different countries of the world as might have been reasonably expected. The cottons of the United States, although much the best in the Exposition, were by no means a fair sample of that greatest of American products. On account of the lateness of the time at which our government accepted the invitation to be represented at the Exposition, and of the short notice given the planters and boards of trade throughout the country, but a very small quantity could be collected.

Reasons for the limited exhibit by the United States.

The crop of 1877 in hands of manufacturers.

Nearly all the crop of 1877 had found its way to the manufactories, and certainly the very best grades had been consumed; so that the samples we were enabled to procure were small and not so excellent as might have been procured earlier in the year. The whole cotton exhibition of the United States did not amount to more than 7,000 pounds, but the exhibition was rich in its great variety of kinds.

Limited opportunity of obtaining exhibits at so late a period.

Mississippi and Texas not represented.

The most extensive cotton-growing section—that embraced by the States of Mississippi and Texas—was not represented; and the board of trade of New Orleans, the great market of the world, sent only a box of samples showing the grades of classification. The cotton on exhibition from America was in bales, and was sent by the boards of trade of Augusta, Ga., and Memphis, Tenn., the chamber of commerce of Charleston, S. C., and by private individuals. I am sure that the three bales of sea-island cotton sent by these gentlemen could not be excelled, and, in my opinion, was never excelled for fineness of tissue and length of staple. The bale of cotton sent by Mr. Lafitte, of New Orleans, was a first-class sample of Louisiana uplands or short staples; but the bale of uplands exhibited by the Memphis board of trade had been handled in pick-

Exhibits by boards of trade.

Sea-island cotton by individual exhibitors.

Grand prize to Memphis board of trade for bale of uplands.

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ing and packing with remarkable care. The fact that this package of cotton won the grand prize was not a surprise, for it was universally pronounced to be the finest sample of uplands in the Exposition. The chamber of commerce of Augusta, Ga., sent four packages of uplands, weighing about 2,000 pounds, showing the grades of cotton produced in that section, and also the classification of cotton in that market. This parcel of cotton attracted much attention on account of its variety. The small quantity of cotton sent by the chamber of commerce of New Orleans was merely a collection of samples of the different market grades, and really a very fine display of samples showing the grades in the classification of that chamber. There was a very small quantity of cotton in the boll and a small quantity in the seed.

Packages of uplands by chamber of commerce of Augusta, Ga.

Samples showing grades by chamber of commerce of New Orleans.

Next to the display of sea-island cotton of Mr. Townsend and Mr. Smith, of South Carolina, the best parcel of cotton I found was two packages of long staple exhibited by the Ryder Bros., of Mango, one of the Fiji Islands. This cotton was of a most beautiful and silky texture, and it had been handled with great care and skill in gathering, ginning, and packing, but it was not so long in staple as the cotton of the South Carolina islands, nor so strong.

Sea-island cotton from South Carolina.

Fiji long staple cotton.

INDIA.

INDIA.

One of the best displays in the Exposition was the India cotton, but in small quantities. Nearly all the classes of this cotton are varieties known in America as the long-staple cotton. However, there is grown in India quite a quantity of the Nankin cotton made in Bengal. The cotton crop of India, as far back as 1834, was estimated by Mr. Levi Woodbury, the United States Secretary of the Treasury, at 185,000,000 lbs., but it was thought this estimate fell far short of the crop of that period, for in 1818 90,000,000 lbs. were made, and in 1836 80,000,000; and in 1841 upwards of 1,000,000 were exported to America. In 1818 5,000,000 lbs. were sent to China, besides quite a quantity which was used in the manufacture of cotton in India, and some was exported to other parts of Asia and to Europe.

Long-staple cotton.

Nankin cotton.

Cotton crop of India in 1834.

It has been estimated that it was necessary to retain 380,000,000 lbs. for consumption in India, supposing that each inhabitant would use 2½ lbs. Another writer says that each individual in India consumes 20 lbs. of cotton per annum, which would be equivalent to 2,000,000,000 lbs., which was the average crop between 1840 and 1846. Bengal, Behar, and Benares have long been famous for the

Consumption of cotton in India

Cottons of the Ganges Valley.

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INDIA.

manufacture of their cotton goods; and these provinces have produced large crops for their own use, and also drawn much cotton from distant regions of Central India. Some of the most important factories now in operation are in Benares and Bengal, drawing large quantities of cotton, frequently by sea, from Surat. We find from estimates in 1799 that the weavers depended much upon the country cotton imported into Bengal, and that much of this cotton was imported from Central India.

Cotton manufactories.

Cotton appears to have been indigenous to the soil of India; we first hear of it in that country. From India it seems to have gone into China, and does not appear to have been used there before the ninth century, when a traveler, describing his journey through the country, says that the Chinese were not dressed in cotton goods, as were the people in India. We know that in the thirteenth century certain cotton manufactories existed in China. It cannot be determined when cotton was first introduced there, but it is supposed that it came from India; from India, no doubt, into Persia, Arabia, and Egypt; and from Persia to Africa and Asia Minor. Cotton was first found in America in the West India Islands, also in Mexico, by Cortez. Cotton was, for several hundred years back, the principal clothing of the Mexicans; it was raised largely in the warm regions of Vera Cruz. Cotton has also existed in the Sandwich Islands, very fair samples of which were on exhibition at Paris, as was cotton from Borneo, Java, and other islands of the Indian Ocean.

The cotton of commerce indigenous in India.

Introduced thence into China.

Spread of the culture to Egypt, etc.

To America.

The native Mexican cotton.

Cotton of the Pacific islands and Malaysia.

The samples of cotton from Mahratta, in India, and Dhurwar attracted my attention, as they seemed to be superior to most of the other Indian cottons. They are clean, bright cottons, but, like most of the Indian cottons, coarse and short. From this exhibition I learned that the cotton of all or nearly all of the Indian provinces has been greatly improved by the introduction of American seed. It was in Dhurwar that our American planters obtained the greatest success, and I am told that the entire crop in this province is now from seed originally American. These districts are reported to enjoy a climate resembling that of the American Gulf States, never excessively dry and never overflowed with excessive rains. In 1844 there were, it is said, 1,200 acres planted in American seed; in 1848 between 18,000 and 20,000; and in 1860 the crop was said to be over 2,000,000 lbs. When the American War of Secession seemed inevitable, England proposed again to husband the production of cotton in India; for it appears that, for some reason, the

Bombay cottons.

Dhurwar.

American seed cotton.

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INDIA.

American planters who had been employed years previously to instruct the people of India in the culture of cotton had left the country and returned to their homes, and that after their departure the production seemed to diminish, while the improved implements of agriculture which had been introduced by them had been thrown away or at least passed out of use by the natives. One author states that some English plows were introduced by the agent, when at first the natives were greatly astonished at their results, and admired them extravagantly; but when the agent turned his back they painted the plow red, turned it up on end and worshiped it, and returned to the use of their original clumsy utensils. The attempts of England to produce her own supplies of cotton from her own territory, and thus become independent of the product of America, seem to have been a failure. Nor has the experience in India been exceptional, for about the same period an attempt was made to extend its cultivation to Africa. The islands of the West Indies, as a field of supply, seemed to be closed forever, because of the emancipation of the slaves in those islands. It was the expectation of British statesmen that America would share the same fate in the failure of cotton culture after the emancipation of slavery in the Southern States; and that, the monopoly of the American planters being thus destroyed, the price of cotton would necessarily rise, so that it could be grown and exported with a profit from other fields, and especially from their own tropical possessions. In this they were disappointed; for, although agents were employed at high salaries in the provinces of India and Africa, and under their direction the culture of cotton seemed to have received a new impulse, yet, when the agents left, the cotton-growing interests languished and the supply diminished.

Disuse of American implements.

England's attempts to supercede American cotton by Indian not successful.

Difficulties of the culture in the West Indies.

Expected decrease of American supply following emancipation not fulfilled.

Cotton of—

Guiana.

Lagos, Africa.

Seychelles.

The specimens of cotton from Guiana attracted my attention as being of a good grade of American uplands, of good staple, and fine tissue. The samples from Lagos were inferior, of short staple, and coarse and yellow. Those from Seychelles were of a much finer quality, being good specimens of long or sea-island cotton. It had evidently been handled with great care and skill, the fiber being long, silky, and of a dazzling whiteness, but the staple not so long as the cotton of Edisto Island, in South Carolina. I am informed, however, that the crop is very light, only a small quantity being produced in certain localities of the island. Except the cotton exhibited by the Ryder Bros., of Mango, Fiji Islands, this was the best sample of foreign cotton I found in the Exposition.

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EGYPT.

EGYPT.

I next came to the specimens from Egypt, which were very numerous, and embraced many different varieties. Previous to the year 1820 the cotton-growing interest of Egypt was small and of little importance to other countries, as almost the entire crop was consumed by the natives of the country. Mohammed Ali, then ruler of Egypt, gave much attention to the production, and under his administration the new variety of cotton known as *Jumel* or *Maho* cotton was produced in large quantities. In 1823 the crop of cotton reached over 6,000,000 lbs., but the greatest portion of this was known as cotton *Belledi*, an inferior kind known in England as *Surats*. As early as 1822, I am informed, the Nankeen cotton was imported from Malta, and for several years it was produced in Egypt quite extensively; but at this time but little of it is found. This cotton was once produced to some extent in the United States, but for some reason it has entirely or almost entirely disappeared. I found some beautiful specimens from the valley of the Nile, known as *Soudon* cottons; it is of a long staple, very fine and white, and comes from the black seed which produces the long or sea-island cotton. The greater portion of the specimens of Egyptian cotton were of the *Jumel* variety, and are very much like the *Surats*, yellow, short staple, coarse, and very dirty and stained; there was much dirt and trash in these samples. The specimens of Allini, Kafi Hommun, Gallini Salka, Amouni Zagarie, and some samples of the Lower Nile were all of about the same grade of cotton, and were much inferior to the American middlings; but one sample of Souakim and Messir was of a beautiful upland variety, and would easily reach the grade of American middlings.

Increase of cotton culture from 1820 under Mohammed Ali.

Crop of 1823.

Varieties of Egyptian cottons.

Generally inferior to American middlings.

Good sample of uplands.

The most remarkable specimen of cotton I found in the Exposition was a variety of cotton known as the *Bamiéh*, and said to be a cross between the okra and the cotton plants. The okra is largely grown in Egypt as a vegetable for the table, as it is also in the United States, where it is often known as gumbo. I am told by M. Boulad, an extensive cotton grower near Alexandria, in Egypt, that it is a custom with many people there to plant the okra in the cotton fields, and that a few years ago a planter discovered some cotton bolls growing upon the stalks of the okra, whereupon he planted some of the seed from the okra stalks, or rather from the cotton on the okra stalks, and produced a cotton short and coarse, but very prolific. It is said that this variety produces at least one-third more to the acre than the

Bamiéh cotton, a hybrid.

Its origin.

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EGYPT.

ordinary cotton of Egypt. The stalk of the okra is much taller and stronger than the cotton stalk, and produces many more branches and much shorter than those of the cotton stalk, which enables a greater number of plants to be grown on the same quantity of ground. This cotton is of a very short staple, coarse, and resembling wool; the seed is black and small. M. Boulad seems to think that this cotton is a great discovery, and will eventually be largely grown in Egypt. Steps have been taken to give it a fair test in the Southern States of America, and, if it should prove a success, the seed can be easily procured in any quantity necessary by applying to the Commissioner of Agriculture.

The *Bamieh* cotton.

M. Boulad.

Ahmouni cotton.

The cotton of Batra Ahmouni, an Egyptian cotton, is a coarse, long-staple cotton, resembling the long cottons grown in the main-land and in the interior of Florida from the black seed. The specimens from Rhoda, in Egypt, are of about the same grade as the other Egyptian cottons, and all of these are of the same class as the *Surats*.

Mode of cotton cultivation in Egypt.

Triennial cotton.

The cultivation of the cotton plant in Egypt is very different from that in the United States. The *Jumel* or *Maho* is often planted only once in three years. In the selection of ground for the crop the preference is given to that which is strong, rich, and retentive of moisture, where the shrub can acquire an abundant sap, and furnish well-filled pods. The lands bordering on the Nile are greatly preferred, as the plant can be more easily watered, and with much less expense. The river lands are protected against the inundations of the stream, as continued exposure to the water would destroy the plant; and great pains are taken by the farmers in constructing dikes along the stream, around the lands in cultivation. The cotton plants are watered periodically, without which they would not mature; in winter they are watered about twice a month, and in summer three or four times as often. Immediately after the planting the ground is watered, and the watering is continued for the three years that the plant produces. In some parts of Egypt the land to be planted is worked or plowed only once. In the upper provinces, however, where the land is light and mellow, the ground is worked twice. At the time for planting, the furrows are run about 4 feet apart, the ground having been broken to the depth of about 10 inches. The seed are planted in holes made about 3 feet apart in the furrows; the holes are about 3 inches in diameter and about the same in depth. The seed before planting are soaked in water to hasten germination. The planting takes place in March and April.

The land on the Nile border preferred.

Dikes.

Irrigation.

Plowing.

Planting.

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On many of the small farms, I am told, the plow is never used, but the ground is broken with a kind of heavy hoe, and sometimes a narrow spade; and the hoe is almost exclusively used in the cultivation. It is customary with some of our American farmers to top the cotton when the stalk grows to a great height, the theory being that if the top is taken off the branches are thrown out to a much greater length, and by this means they produce a much larger quantity of fruit. In Egypt, however, almost the opposite course is pursued. There they prune the plant, lopping off the branches, thus encouraging the plant to grow much taller, and forcing the fruit to be produced on the main stalk. The pruning takes place the first year and is repeated during the second and third years. The plant often grows to the height of seven and eight feet in Egypt. Of late they have ascertained that by planting every year they get a better yield, and the grade of cotton is much higher than when it is allowed to grow for three years. The gathering of the crop commences about the same time as with us—in the latter part of July—and extends often to January. One person usually cultivates four or five acres, and the crop is from 1,000 to 1,500 lbs. per acre.

Cotton culture.

Cultivation.

Pruning.

Better success of annual planting.

Gathering.

Tasks.

Crop.

There are comparatively few gins in the country. Only the more extensive planters have them; and they do the ginning for the poorer classes. American roller-gins are mostly used, the saw-gin not being well adapted to the class of cotton raised in Egypt, as the staple is long and kinky. The cotton was formerly pressed into the bales by the natives with their feet; in many localities they now have the modern presses.

Gins.

Roller-gin preferred.

Baling.

The cotton culture in Egypt is a government monopoly, and hence the crop is much smaller than it might be if the culture were encouraged by the government by allowing perfect liberty in its production. As has been before said, the introduction of American seed of sea-island cotton into Egypt has enabled them to produce a much better grade of cotton than formerly, yet they have never been able to produce a cotton to approach the American sea-island in fineness of tissue or length of staple. After careful investigation, I am of the opinion that the cotton-growing people of the United States need have no fear that the culture in Egypt will materially interfere with them; for it is absurd to suppose that the ignorant farmers of that country, who use only the rude implements of husbandry known to the world two thousand years ago, can ever compete with people who employ all the most recent appliances of agriculture, and who use the best-known fertilizers.

Cotton culture.

Introduction of American sea-island seed.

Egyptians handicapped by ignorance.

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Culture of cotton in Egypt not increasing.

From statistics embodied in this report it will be seen that the cotton culture of Egypt is not materially increasing, but, on the contrary, is falling off, while that of the American States is rapidly increasing. I venture an opinion that if the Texas or Southern Pacific Railway is constructed, in less than ten years the State of Texas alone will produce 3,000,000 of bales, and the crop of the United States will double the production of all the other countries of the world. However, this will in some degree depend upon the facilities and cheapness of transportation of grain from the Northwestern States to the cotton districts of the Southern States.

Prospects of cotton culture in Texas.

Proposed internal water communication between the Mississippi and Atlantic.

If a water line, such as has been surveyed by the United States engineers, could be established from the Mississippi River through the cotton States to some point on the South Carolina or Georgia coast, it would enable those States along the Atlantic to greatly increase their crops of cotton, as the lands now used for growing corn would be devoted to cotton, corn being brought from the West much cheaper than they could produce it.

Egyptian crop of 1878.

The crop of Egypt for the year 1878 was very short, indeed almost a failure, not reaching over 119,000,000 lbs., which is about the estimate at the time of writing this report. This is a great falling off—almost half of the average yield. The cotton of 1878 was far inferior in quality to the usual crop. The exports of cotton from Egypt for the three preceding years averaged over 287,000,000 lbs. per year. The failure of the crop of 1878 was owing to the lowness of the Nile the year preceding and the unprecedented overflows in 1878. Over two millions of acres, or more than two-fifths of the arable lands of Egypt, were inundated in September, 1878; and this included most of the lands of Lower Egypt, which were in corn and cotton.

M. Habité Boulad.

I am much indebted to M. Habité Boulad, one of the most extensive cotton-growers of Egypt, for valuable information concerning the cotton crop of that country. M. Boulad plants largely in cotton near Alexandria, in Egypt. I urged upon him the opinion that if the Egyptian planters would adopt some of the methods of cultivation used in the United States, their yield would be greatly increased; but he seems to think that our culture is not adapted to the thick, stiff, sticky soil of Egypt. I differ greatly with him in this opinion, as small plows of great strength could be made that would effectually break up this stiff earth much more rapidly than it is now broken by the natives with their rude, old-fashioned implements. There is a soil very hard to break in the bottoms of the Mississippi, but it is broken by

Opinion that American methods of culture are not adapted to the soil of Egypt.

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EGYPT.

strong plows and plenty of horse-power, and I think it might be managed in the same way in Egypt. But I am informed that very little stock is to be found there, and the natives are too poor to purchase mules or horses for agricultural purposes. The crop is principally cultivated with a kind of hoe, and in many cases the ground is not plowed after the crop is planted.

Comparison of American and Egyptian soils and methods.

I am further indebted to M. Boulad for the following account of the method of cotton culture in the region of Alexandria:

The cotton culture of the Delta.

"There are three kinds of cotton cultivated in Egypt: (1st) the cotton, long staple, somewhat reddish in color (*Ahmouni*), which gives the largest yield; (2d) the white cotton, short staple, with black seed; (3d) the cotton, long staple, which is cultivated but little.

Kinds.

"The ground is plowed four times, during the space of two months, with a plow to which two oxen are harnessed, and afterwards the furrows are opened to the depth of 15 centimeters, and to about the distance of 80 centimeters. The planting is then done in two ways: (1st) The furrows are submerged with water during four or five days; then, with the aid of a small implement (*brêche*), holes are made at a distance of 50 centimeters apart; in each of these holes are dropped several seeds, which have already been soaking in water for 24 hours, and then they are covered with a little earth. Twenty or thirty days afterwards the worthless plants are pulled up, in order to leave only the two most vigorous ones in each hole, and then the ground is watered in moderation. The operations once finished, one continues to water and to sweep (*brêchar*) the cotton during twelve or fifteen days, in fact, until one can no longer reach the cotton. (2d) After having planted the seed dry in the holes made in the trenches of the furrows, the ground is watered, and one waits twenty or thirty days, in order to give the plants time to grow. Then, as in the first instance, the worthless plants are torn up, in order to leave only the two strongest in each hole; then one continues to water and to sweep the ground during twelve or fifteen days, as we have already said in the above.

Mode of plowing.

Planting.

"This is the way in which the *Miskawi* cotton is cultivated. It requires frequent watering; in fact, water is more essential to it than to any other species of cotton.

Culture of *Miskawi* cotton.

"As far as concerns the *Bahli* cotton, which is planted dry, it is cultivated in the following manner: In the month of January the ground is plowed twice and submerged with water. Thirty days afterwards the ground is again plowed twice, and is divided in straight lines; then on the straight lines holes are made at the usual distance apart, and the seed are dropped in and covered lightly with earth, and watered sparingly by means of a watering-pot. Sixty or seventy days afterwards the worthless plants are torn up, as usual, and one begins by sweeping and watering, as in the above-named cases."

Of *Bahli* cotton.

FRENCH COLONIES.

FRENCH COLONIES.

I found much to admire in many of the samples of cotton exhibited by the French colonies.

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FRENCH COLONIES.

MARTINIQUE.

Martinique.

One of the most beautiful was a specimen of cotton from the island of Martinique. It was of long, glossy staple, fine tissue, and had been carefully handled in the gathering and manipulation. It much resembles the cotton known in New Orleans as the *Peeler cotton*, a very superior kind. The crop is as yet small, but, I am told, is rapidly becoming more important.

Tahiti.

TAHITI.

The samples from Tahiti were of about the same grade of cotton as those of Martinique. There was, however, one sample of a very peculiar kind; it is of short staple, rather coarse, but very white; its seeds are most singularly arranged, being all connected together, and resembling the rattles on the tail of the rattlesnake. The seed are black, but it is evidently a short-staple cotton.

Cochin China.

COCHIN CHINA.

The samples from Cochin China resembled those of Martinique, being soft, long, and of fine staple. The crop is increasing.

New Caledonia.

NEW CALEDONIA.

The samples from New Caledonia were much like those just described, probably not quite so good. They have a long staple, but not so fine as that from Martinique. The crop is yet small. This cotton is said to be produced from American seed of sea-island cotton.

Gaboon.

GABOON.

Samples from Gaboon were almost the same as those of New Caledonia, perhaps somewhat inferior.

Guiana.

GUIANA.

I found a very fine boll of real American upland cotton from Guiana. The boll is very large, and of first-class quality; the seed is white, and in all respects it is the cotton of Georgia, South Carolina, and Alabama. The staple seems to be a little too short, but it is of a glossy whiteness. I found also a sample of very inferior Nankeen cotton from Guiana, of which I think but little.

Réunion.

RÉUNION ISLAND.

From the Réunion Island (formerly Bourbon) there was on exhibition a sample of very superior quality of long or sea-

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island cotton, both in the seed and ginned. This cotton was well manipulated. It is much like the cotton from Queensland, and if these samples had been large enough to appear in bales it would have competed for the first prize.

FRENCH COLONIES.

Réunion.

GUADELOUPE.

Guadeloupe.

Guadeloupe sent some samples of sea-island and of Nankin cotton. The sea-island is of a tolerable quality, but the bolls are very small and very full of seed. The sample of ginned cotton from this island was very beautiful, but in small quantity.

SENEGAL.

Senegal.

There were two samples from Senegal, one of sea-island and one of the short staple with white seed. The short-staple sample is very good, but of extremely coarse fiber, and very short, white, and glossy. It has the touch of wool when rubbed between the fingers. I should think it a very valuable cotton to combine with wool in the manufacture of light goods.

ALGERIA.

Algeria.

Excellent long staple cotton.

The samples of cotton from Algeria were exceedingly interesting, on account of their variety. The samples from the neighborhood of Oran were of an excellent quality of sea island and also of Nankeen. The sea island is as good as that from Queensland; it is very white, and quite as long. If it had been presented in large quantity it would have entered into the competition for the first prize; but unfortunately the samples were much too small to be taken into serious consideration, for it is well known that small quantities may be produced by artificial means in almost any country, and therefore a small sample of an ounce is, in fact, no sample at all.

The samples from the region of Philippeville, in Algeria, were of two varieties, sea-island and upland, both very fair samples. The upland cotton of this region is of very short staple, but white; the fiber is coarse, and resembles the "wool" cotton of the United States.

TUNIS.

TUNIS.

The samples of Tunis were all of a short staple variety of an inferior quality. The parcels were so small that no just idea could be formed of the product. The crop is so small that it is of little interest.

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PHILIPPINE ISLANDS.

PHILIPPINE ISLANDS.

The samples from the Philippine Islands were of two varieties of short staple—one a poor grade of upland cotton, the other very inferior and yellow. The crop in these islands is of but little importance.

HAYTI.

HAYTI.

The samples from Hayti were all of short staple and quite coarse. The crop is small, and the cotton of an inferior quality. From all I can hear, the soil in this island is well adapted to the growth of all classes of cotton; but the natives are lazy and trifling, and the probabilities are that they will never produce a good crop of cotton, as the cotton plant requires constant and careful cultivation. If the island had anything like a good and intelligent government, it would soon become one of the best cotton-growing regions of the world for sea-island cotton.

SPAIN.

SPAIN.

The samples from Spain were few in number, and very small. There was one sample of very white short-staple cotton, not remarkable except for its glossy whiteness. There was another sample of a very curious kind of cotton —yellow, not so dark as the Nankeen, but of a rich creamy color, and the staple is short, and so very fine that, when separated, a single shred can scarcely be seen by the naked eye. It is as soft and fine as the finest silk. This comes from the province of Glocas.

PORTUGAL.

PORTUGAL.

The samples from Portugal were few and small. The soil and climate of this country are adapted to cotton-growing, but it is but little pursued, I suppose from the fact that other products are more valuable. The samples on exhibition were all of the short-staple variety, and were not good specimens.

Portuguese colonies.

PORTUGUESE COLONIES.

The colonies of Portugal sent some fair samples of short-staple cotton, most of the samples in the boll.

ITALY.

ITALY.

Italy sent a large collection of samples, comprising many varieties of long and short staple cotton, but the samples

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ITALY.

were so very small that it was difficult to form any idea of their value or the extent of the culture. The cotton-growing interest seems to have received a new impetus in Italy in the last few years. I found a large book of drawings in the Italian exhibit, showing a correct drawing in water-colors of each variety of cotton produced in Italy. I obtained much information from this book. Brindisi sent some good samples of short-staple cotton in the boll, similar to American upland cotton. In this collection I found two samples of short-staple cotton from Salermo, one very white and coarse, the other the ordinary Nankeen. The different varieties are too numerous to mention in this report, and as many of them are only the result of experiment on a small scale, I shall not dwell upon them. The soil of the greater part of Italy is well adapted to the production of cotton. With its great population of women and children, it is a matter of wonder that they do not cultivate this staple on a larger scale. The soil is rich and very productive, but the natives are poor and ignorant, and in many instances they use the most inferior old-fashioned agricultural implements, often using plows made of wood only to break up the ground; and of course they only cultivate a few inches below the surface. In many localities I found only a small donkey pulling a plow, cutting only about three inches below the surface.

Varieties and qualities.

JAPAN.

JAPAN.

This country is growing rapidly in importance to the United States as well as to all nations of the world. It is difficult to ascertain at what period cotton was first produced in Japan, and it appears to be very difficult to ascertain the exact extent of the culture in that country at the present day. On account of the peculiarities of the government of Japan, but little was known of that country until a few years ago, and comparatively little is known of its agriculture at this time. The cotton crop is, however, each year becoming more important.

The samples on exhibition from Japan were all of the short-staple varieties, and resemble the upland cotton of Georgia and Alabama. The samples were, however, so small that but a poor idea could be formed of the value of this cotton. It would seem, from the character of the soil and the dampness of the atmosphere, that Japan would be better adapted to the culture of sea-island cotton than of the short-staple.

Cottons of the short-staple varieties.

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GREECE.

GREECE.

Quality of cotton.

There were some fine samples from Greece. It has much the appearance of our uplands. The fiber is long, fine, and glossy. The seed differs in some respects from that of the American uplands; it is smaller and more in the shape of the egg of a common hen. The production is not materially increasing. Up to a few years ago Greece imported no raw cotton, nor was she an exporter until recently, in consequence of the heavy duty placed upon all cotton leaving her ports. That export duty, which was 48 per cent., has of late been reduced to 20 per cent. She is a customer to England to the extent of over 1,500,000 lbs. of cotton yarns and 10,000,000 yards of cotton goods. The trade in these articles seems to be rapidly increasing between England and Greece.

Export duties and imports.

The ancient Greeks made use of muslins or cotton cloths of some kind, which were brought from India more than two hundred years B. C. We are told that about sixty years B. C. cotton was used by the Romans for awnings and tent covers.

CHINA.

CHINA.

Large quantities of cotton were produced in China in the thirteenth century. On account of a famine in China about the beginning of the present century the government ordered that a large portion of the land used in the cultivation of cotton should be planted in grain; and since that time the Chinese have imported largely of cotton. It has been, and is even to day, produced in very large quantities.

Estimate of crop.

The Chinese crop has been estimated by some even as high as twelve millions of our bales.

SOUTH AMERICA.

SOUTH AMERICA.

Most of the samples of cotton from the countries of South America were of short staple and coarse fiber, resembling our upland cotton of the United States.

PERU.

PERU.

One very fine sample was from Peru; but they were all in very small parcels, generally not more than a few ounces.

BRAZIL.

BRAZIL.

The best samples were from Pernambuco, in Brazil. Brazil exhibited some good samples of long staple and uplands. The crop of this country is rapidly increasing, but as yet

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BRAZIL.

it does not produce sufficient for home consumption, though much of the Brazilian cotton finds its way to British looms, and is transported back in the shape of cloth of different kinds. There are great drawbacks to the cotton culture in Brazil, among which may be reckoned the ravages of insects, the peculiarities of the climate, and the expense and difficulties attendant upon its transmission from the interior to the coast. It has been ascertained after many attempts that cotton will not flourish near the sea in Brazil, and the plantations have in consequence receded further inland, as well to avoid this difficulty as to seek new and fresh lands. Pernambuco is the principal cotton-growing province in Brazil. This country has been long noted for its fine cotton and for the best cleaned cotton brought to the English market. There were imported into Great Britain in 1869 from Brazil 272,000 bales, of 400 lbs. each. Cotton was first imported into England from Brazil in 1782, and it has been found in the English markets ever since that date.

Drawbacks to culture of cotton.

Coast culture not successful.

Exports to England.

ARGENTINE REPUBLIC.

ARGENTINE REPUBLIC.

There are varieties of both annual and perennial in the Argentine Republic, where the culture of cotton is increasing. About one-half the crop is exported, and half consumed in the country in the manufacture of rude domestic goods for family use, for fringes, and for other purposes. Very little, if any, of the manufactured article is exported.

PARAGUAY.

PARAGUAY.

Much of the country along the Rio de la Plata is well adapted to the culture of cotton. Paraguay produces many varieties of cotton, among them the Nankeen, which is said to grow wild, but was introduced long ago by the Jesuits. There were some good samples from Paraguay, and its soil is said to be excellent for all varieties of cotton.

VENEZUELA.

VENEZUELA.

The exhibits from Venezuela were small but very good, including varieties of both long and short staple. In fact, all the samples from the countries of South America were good, and seemed to have been handled with remarkable care. Besides the varieties just named, there were other kinds, and perhaps of different species, grown in South America. I have a sample before me of the *Nadum* cotton, originally from the jungles of India. It is a perennial, and is of a very inferior quality; is not exported, and is only

Nadum cotton.

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used to a limited extent for home purposes, generally for the adulteration of the finer varieties when prepared for the loom. It is very coarse, of short staple, and when taken between the fingers reminds one of short, coarse wool.

Cotton-seed and products.

COTTON-SEED, COTTON-SEED OIL, AND CAKE.

Uses of the seed.

It may be proper, in connection with this subject, to mention the importance of cotton-seed for its oil, and for its food in the shape of oil-cake. The seed in many localities is

Cattle-food.

used in its rough state as food for cattle, and also as a fer-

Fertilizer.

tilizer for all crops. It is one of the best fertilizers we have in the Southern States of America, especially for corn, wheat, and oats; but it has proved a far greater source of

Manufacture into oil and cake.

wealth when ground up and manufactured into oil and oil-cake. We consider a fair bale of cotton in Georgia to contain 450 lbs. of cotton; it requires about 1,400 lbs. of cotton

Product of seed-cotton in seed and lint respectively.

in the seed to produce 450 lbs. lint cotton, leaving 950 lbs. of seed. Nearly half of this weight is hull and lint; the remainder is cake and oil. It is estimated that out of a

Product of seed in oil and cake.

bushel of seed, weighing 30 lbs., three quarts of oil will be produced, leaving about 10 lbs. of oil-cake, which is very valuable for feeding cattle, horses, and hogs.

Cotton-seed oil.

The oil made from cotton-seed, when pure and refined, has the color, transparency, and taste of olive-oil, and it has the same character for lubricatory and pharmaceutical

Its uses and qualities.

purposes. It has the property of resisting cold, remaining limpid, when pure, at 30° Fah., and quite fluid at 20°, hardening only at 8° to 10°. It is not a volatile oil, like coal-oil or ordinary burning fluid, but a fixed oil like lard, sperm, or olive oil, and therefore does not explode. It gives a brighter light and burns longer than lard-oil, which is owing to the absence of the gum which always exists in lard; and for this reason it is a better lubricator than lard-oil. Coal-oil is of the lowest value among lubricating oils, owing to its volatility.

Sea-island cotton.

SEA-ISLAND COTTON.

Seed obtained from the Bahamas.

The first cultivators of sea-island cotton trace their plant to the Bahamas, and the Bahama seed is said to have been obtained from Anguilla, one of the Caribbee

Spread of the varieties of this species.

Islands. The sea-island and the best Egyptian, the West Indian and the Bourbon, the New Orleans, and the cotton produced in the Gulf and lower Atlantic States are all varieties of one species. That some of these are perennial and others annual is no objection to this theory, for it is

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known that in many cultivated plants varieties which originated in accidents, or were the result of a designed culture, have become permanent in character if similarly cultivated. It appears, indeed, that any tendency, when once given to a plant, may be carried on from generation to generation by a careful attention to the stoppage of all disposition to depart from the new character. So with cotton itself. The Indian species, which is annual in the south of Europe, produces varieties which are perennial in their native country. This cotton, cultivated in the West Indies, was perennial, and we have seen that the Mexican plant introduced into some parts of Texas survives for three or four years, and in warm climates it has been known to survive for five years; but all the cotton, both upland and sea-island, now produced in the United States is cultivated as an annual. In India the cotton from American seed is cultivated as an annual, though it may also be grown as a perennial, and has been cultivated there as a triennial. After much experience it has been found much the best plan to plant and cultivate annually in all countries, for the fresh plants grow smaller and bear more fruit than the large ones. The sea-island is very subject to this overgrowth. I have often seen stalks of sea-island in Florida ten feet in height, and it does not bear so well as the smaller plants. Fresh land cultivated for the first year in sea-island will produce tall stalks and but little fruit for that season. It is usual to plant new ground for the first year in corn or grain of some kind. We must keep in mind, as the details of cultivation, the fact that the winter of the Southern States leaves the soil in a moist and cold state, and is followed by frequent rains in the spring, and often in the early summer; the climate is a very moist one. From this arises the difficulty of getting the soil dry enough to plow and to plant. To remedy this defect, the ridge culture was adopted early in the cultivation of not only sea-island but upland cotton in all the Southern States. I have heard of the level or flat culture in Georgia, but I have never known cotton cultivated otherwise than in ridges or hills. The culture at the early stage of the crop is very careful, for the plant is a delicate one and requires warm, dry weather when it is young and tender.

Sea-island cotton.

Indian species which is annual in some countries becomes perennial in others.

Cultivated as an annual in the United States.

American cotton cultivated as an annual in India.

Climatic peculiarities of the Southern States.

A rotation of crops is considered much better for the plant and for the land than a continuous crop of cotton, though I know of one field in Georgia which has been cultivated continuously in cotton for over twenty years, the only fertilizer being stable manure and the *débris* of the

Rotation of crops.

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Cotton culture. preceding crop, plowed in. This field, I am informed, produces just as good cotton now as it did in the beginning, and of course is much easier to cultivate, since the grass and weeds are not so numerous, and the long tap-root of cotton serves in some degree as a breaker of the soil, and also to some extent as a fertilizer. It is supposed that all

Effect of previous root crops. root crops are disadvantageous to the ground intended for the culture of cotton, and that if root crops have been produced on ground intended for cotton, a crop of grain of some kind should intervene before the planting of cotton upon the same ground. One of the most successful growers

Continuous cropping. of cotton I know prefers a continuous crop without rest or rotation of crops. He believes, and his belief is strengthened by experience, that the land, when well broken and perfectly fertilized and well cultivated, produces better crops and of a finer variety each year that it is cultivated

System adopted. in cotton. In the late autumn he plowed up the old stalks with a heavy two-horse plow; the women and small hands follow the plow, gathering the stalks and trash, and placing it in the furrow; and another plow follows and covers this under with two furrows, one on each side, forming a ridge which is to be the nucleus of the ridge or bed for planting the next year's crop. In the following spring this ridge is opened with a small plow, a light fertilizer is put in, and the planting begins. The plants receive nourishment from the decayed stalks and bolls, which furnish the elements of vegetable matter with which it is necessary to reinvigorate the soil and give back to it that which has been taken away by the crop of the preceding year. When ground is intended to be planted in cotton it should be well broken by heavy two-horse plows; then it should be thrown into

Ridge planting. ridges from six to ten inches in height and from four to six feet apart, according to the richness of the soil or the kind of cotton to be cultivated. In poorer soils the ridges are narrower and closer together, so that the plants, which are small, may be able to cover the ground. The ridges allow superfluous moisture to be carried off by the water furrows, which in low situations are made into trenches.

Seeding. The ridges or beds are allowed to remain some time before planting, as the plants take root more vigorously than when they spring up in freshly plowed and loose earth. When the ground is quite prepared, a one-horse drill makes a slight furrow from one and a half to two inches deep along the center of the ridge; the sower follows and drops in the seed quite thickly. These are immediately covered by a light harrow, which also smooths the ridge.

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Cotton culture.

In favorable weather the plants make their appearance in five or six days, and are thinned out as soon as they put forth the third or fourth leaf. This operation is performed by scraping out with a hoe all the superfluous plants and weeds, leaving three or four together, with spaces of twelve or fourteen inches between them. When the plants are sufficiently established, they are reduced to a single one, and care is taken to remove every particle of grass or weed. A light furrow is then run, with a one-horse plow, within five or six inches of the plant, turning the earth towards the roots, and even drawing it around them with the hoe, in order to supply the place of that previously removed by scraping. Hoeing and plowing are frequently repeated, so as to keep the ground free from weeds and grass. One crop is often plowed as many as four times and hoed three times. The best farmers plow until the first bolls begin to open. It is essential to keep the ground clear and constantly stirred. The plow most generally used after the first plowing is called a "sweep," and has "wings" on each side. Generally two "rounds" between rows with the sweep will clean the balk of all the weeds and grass not immediately in the line of the cotton. The above process, besides loosening the soil and keeping it clean, must assist in drying it. The cotton plant is one of those having a tap-root, which, according to the dryness or moisture of the season, will penetrate from one to one and a half feet in the former, and perhaps not more than six inches in the latter. The plant may be fine and thrifty-looking in a moist season, when there are only short roots, but in a dry season the roots penetrate deeply, obtain a supply of moisture from a greater extent, and are necessarily better able to bear drought and the vicissitudes of seasons.

Thinning.

Ridging.

Cultivating.

"Sweep"-plow.

Habit of the plant.

Affected by the season.

The cotton planted towards the end of March, or even as late as the 20th of April, attains in six weeks or two months what the planters call a good stand; that is, plants well grown and healthy, and at intervals proportioned to the richness of the land. About the 1st of June the weather becomes hot and the air dry. This checks the upward growth of the plant, while the root continues to penetrate deeper, and has thus to supply a smaller bush and less wood at the very time when there is a tendency to the production of flowers. But when the parts of vegetation have grown freely in consequence of a moist season, the roots, being easily supplied, spread little, and will be found small in proportion to the size of the plant. Here the hopes of the planter cannot fail to be disappointed when drought comes on, though

Progress of the plant.

Deep rooting or otherwise.

Effect of drought.

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Cotton culture. in the other case he has often been surprised with a good crop when the appearance of the plant above ground did

Topping. not seem to him to give much promise. Topping or pinching off an inch or two of the top of the plant is not always necessary, but it is useful when there is a tendency to the production of wood and leaves to the detriment of flowers and bolls. When the farmer resorts to topping, it is done about the time when the plant begins to form pods, or about the beginning of the fourth month after planting.

Picking. The cotton should be gathered or picked as the bolls open, not leaving it exposed to the dews or sun. If it is dried

Drying. under cover, it will materially add to its glossiness of appearance. In gathering, care should be taken to avoid trash, leaves, or dirt of any kind, as in the process of ginning the dry leaves and other trash are likely to be ground up by the machinery and left in the cotton, which is likely to depreciate the value. Often the plant is overtaken by

Effects of frost. frost in October and November, which kills the leaves and the green bolls. The sun dries them rapidly; then the dews and rains may follow; and the drippings from the dead leaves and bolls, falling upon the open cotton not yet gathered, gives it a deep dirty yellow color, which carries it far below the price for the white cotton which was gathered earlier in the season. This cotton all falls under the head of "stained cotton," and is affected in the market according to the extent of the stains. Again, if allowed to remain long in the bolls, it is subject to be blown out by the winds and beaten out by the rains. In either event it falls upon the ground and becomes stained and soon rots.

Introduction of sea-island cotton. The first experiment in the culture of sea-island cotton was made in Georgia in 1786. It was then called Persian cotton, from the country of its supposed origin. The seed was sent from the Bahama Islands by W. Tattnall, surveyor-general, to Governor Tattnall, of Georgia; and the first bale exported was from Saint Simon's Island, in 1788. From the delicate and peculiar organization of the plant, its great susceptibility to sudden changes in the temperature, and

Necessity of a salt atmosphere. the necessity of a salt atmosphere for the length and perfection of its staple, its culture is confined between the

Habitat. parallels of 30° and 33° north latitude, and extends only as far westward from the Atlantic as the head of salt-water navigation. Hence the name of sea-island.

Culture of sea-island cotton. In writing practically, considering its culture as a system, there is this difficulty, that perhaps no plant of either the field or the garden has been treated in a greater variety of methods, resulting from the differences of soil, the localities

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of the islands, the judgment of the planters, and somewhat from the description of the seed. As a general practice, the seed was sown in ridges or beds, from four and a half to five feet in length. The manures were salt mud, taken from the river at low water, salt marsh, mud and marsh combined, composts, guano, etc. It was generally the practice to manure every foot of land planted. This, however, has been the case only since the application of steam to gins. The area per hand was from three to six acres, depending upon the texture of the soil, the quantity of grass, the quality of cotton, and the use of the plow; for, strange as it may appear, in this era of labor-saving implements, on many plantations on the islands plows never entered the cotton field at any stage of the process.

Cotton culture
Sea-island.
Seeding.
Manures.
Area per hand.

It is usual to lay by the crop about the third week in July or beginning of August, depending upon the season and condition of the plant, when the hands were turned into the woods and to the river for manures. The women raked the dead leaves of the pine and oak, the dead marsh sedge on the river shores, where they piled them in the wood, or in the coves at half-tide mark (for the action of salt water), in "cords" of about 9 feet square and 5 feet high, which were staked out regularly under the eye of the foreman or manager. This work was estimated by the watch, and eight hours' work per day was the maximum task for an ordinary hand. As each cord was completed, the hand left work without orders. The men were put in flat-bottom boats, three hands to each "flat," provided with short hand-scythes, manufactured for the purpose. At high water or at half-tide they pulled with oars out into the marsh, grounded their flats, and mowed the green marsh, landing and returning with the flood tide. This work continued from three to six weeks, and, as the cotton opened, details were made for picking, and usually from the first week in September to the last of October all hands harvested cotton. The average quantity gathered per hand for the season of seventy-eight days was from 30 to 40 lbs. per day, according to the yield and fiber. The finest qualities required 1,500 lbs. of seed cotton for bales of 310 lbs.; the ordinary, from 1,100 to 1,300 lbs.

Laying-by.
Gathering manures.
Tasks.
Mowing the marshes.
Picking.
Seed cotton per bale.

Great care is observed in gathering cotton to keep it free from trash, etc. The hands are provided with sheets of osnaburgs six feet square, and a bag. The sheet is spread out on the ground; the hands gather in bags and empty on the sheets, picking out any trash which may have been carelessly gathered. In the evening the sheets are

Cleanliness in gathering.

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Cotton culture. Sea-island. tied up, carried to the cotton-house, weighed, and piled. In the morning, at sunrise, the hands are on the scaffolding—a platform of boards some four feet from the ground, and large enough to accommodate all the pickers—on Moting. which they "mote" the cotton, in their sheets of the day before, until the dew in the field has evaporated, when they empty the sheets upon the scaffolding, and go to the field. Drying. The cotton is now spread out by the woman in charge of the cotton-house with a rake, and is repeatedly turned in the sun until evening, when it is piled in the house; the yield of each field in a separate bulk. On or about No- Ginning. vember 15 the steam-engine and ginning apparatus were overhauled and cleaned up for work. Seven or eight of the most careful women, one man as packer, an engineer, and a boy attended to the preparation of the cotton for market. McArthur gin. With the McArthur gin—three gins to a 6 or 7 horse-power—two were kept working, and turned out from one to two bags per day, the third being held as a reserve in case of accident. While this work progressed, the "flat" hands were kept at the marsh cutting, but knocking off on cold and wet days, and the remainder of the women still Hauling manure. gathering trash. The mule carts and wagons hauled the corded trash to the cattle-pen, which, for ninety head, covered 100 ft. square. The ox-wagon hauled salt mud from the river into the pens, and covered the trash with from 8 to 10 inches of mud. These pens were built up in alter- Composting. nate layers of leaves and mud, trampled at night by the cattle, until they measured 4 ft. deep of compact compost. It was usual to build two pens at once; while leaves were being hauled to the one, mud was carried to the other, thus Character of the soil. alternating the work. The soil of the sea-islands is composed of yellow and gray sands, either from 10 to 15 ft. deep, or resting on a clay substratum, some 15 or 20 ins. from the surface. The clay easily crops out. The first are Light and heavy lands. called light and the latter heavy lands, and the compost manures on them are differently treated. For the first, light lands, which drift to an injurious degree in high winds, the compost is heaped in parallel rows 90 ft. long, 20 ft. wide, and 7 or 8 ft. high; and is allowed to ferment until it becomes short manure.

Preparation of the manure for the respective soils. It is usual to heap the manure just after a heavy rain, so as to retain all the moisture possible, when, in about two weeks, it becomes short, and is ready for hauling. For moist, heavy lands the compost is not fermented. The reason for this is that long manures will in time make heavy lands lighter, but if used in light lands render them still

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more liable to drift. It is thought, therefore, more economical to apply short manure, although it is very much depreciated in its value by the process of fermentation. Generally field work for this crop began on February 1. All the carts (one pair of wheels to four hands) now hauled at the rates of 80 loads of compost or mud, or 12 or more cords of marsh per acre. This was spread in the alleys between the rows—21 to a task, or 84 rows per acre, where the cotton grew to 5 ft. or upwards; 96 rows for cotton of less growth.

Sea-island.

Spreading manure.

On the 1st of March a heavy two-horse mold-board plow, with the best team, commenced to bed up the land, turning the furrow over the manure some 7 or 8 ins. high, running two furrows to the row, working 4 acres a day, passing over 13 or 14 miles of ground. In thirty-nine working days—a month and a half—if not interrupted, one plow prepared 150 acres for planting.

Preparing soil for planting.

The planting began on March 15, and ended on the 1st of May. In planting, the seed was dropped by the handfuls at regular intervals, from 16 ins. to 3 ft., governed by the growth of the plant in previous years. The fields were laid off with task stakes 105 ft. apart each way, making four tasks to the acre, with the number of beds mentioned above. As the cotton began to come up, hands were drawn from the marsh and put to the hoe, and about April 1 the whole force was in the field, banking the beds as heavily as practicable, the task depending upon the soil; if sandy, from one-half to three-fourths of an acre. Grass grows much more rapidly and luxuriantly in the spring on the islands than in the up country, so that when five or six acres of cotton, two of corn, and one-half of roots, etc., is planted to the hand, there is no time to be lost in working cotton, which should be done at least once every eight or nine days. Perhaps the first working, so far as the destruction of grass is concerned, is the most important of the year, for unless it is thoroughly eradicated, by pulling the tops of the beds next the plant, and by picking all that which is cut by the hoes, the labor for the season will be very much increased. It was the practice so to arrange the labor that each hand worked the same ground at every working, whereby his carelessness increased his own labor on the next round. At the first working, the plants were thinned down with the hand to four or five, and on the second to one or two for the stand. In working, there was used the double-mold plow, running one furrow in the alley, the plow going over nine acres, or some thirteen or more miles. The hoes followed, cutting the weeds and hilling

Season of planting.

Seeding.

Tasks.

Banking the beds.

Cultivating.

System of working.

Plowing and hoeing.

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Cotton culture. Sea-island. up the cotton, picking off the grass with the hand. About June 10, or soon after, the first blossoms appeared. These workings continued until the cotton branched out too far for plowing, usually about the first or second working in July, when, generally, the plows were withdrawn and the hoe only used. Long-staple cotton is a much more delicate plant than upland, and requires more care in the management.

Care required. The hoe should never cut near the plant, as the slightest bruise to the stock in its first stage of growth gives what the farmers call "sore shin," from which it never completely recovers, and by which it is frequently killed.

Hand weeding. The fingers only should be used to pull out grass next the plant. The art in planting is to keep the field clear of grasses and the plants growing steadily, and to prevent the top pods from maturing too early. If the cotton has grown rapidly by a forcing season in June and early in July, bearing abundantly, with the top pods well developed, it will be more or less checked in its growth in the last weeks of the latter month, especially if the weather has been dry. Therefore, when a heavy fall of rain in August comes on, the plants are forced into a new growth called the "second growth," booting out from the bottom in long vigorous limbs, whereby the crop, without exaggeration, is injured one-half. The fruit falls by the bushel in the alleys, a new top is formed, and the only one hope is in a late frost. The planters should then so manage as to keep the plants from maturing in July, that the heavy August rains may find them in full growth. To do this, he should watch the top of the plants, see that there are no red stripes on the bark, but that the branches are green and snap off like grass when sharply bent; if of a reddish tinge, it is an evidence of maturity. The crop should then be worked, even if the heads of the hands cannot be seen in the field, and plowed, even at the risk of injuring the lower pods with the swingle-tree; and working should be continued until the August rains set in.

Effect of "second growth" due to July drouth and August rains.

Repressing the tendency to early maturity.

Conditions in a favorable season. If rains have fallen regularly in July, the crop growing well in the first week in August, the crop may be laid by two weeks earlier. Our older sea-island planters never worked a crop after the third week in July; but there is no doubt as to the error of the system, for the reasons just given and from the experience of plow planters. The most successful planter in the Port Royal district plowed in August in cotton spangled to the top with blossoms, with an average height of 6 ft. from the top of the bed.

In planting cotton, whether sea-islands or uplands, the

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safest system is to work until the opening pods demand the harvest. This is the only method, especially in dry seasons, of preventing second growth, which is frequently full as injurious to the crop as the effects of an autumnal storm. With regard to the finer staples of sea-islands, there were but comparatively few planters who devoted their attention to their cultivation. It required great practical observation and a predilection for botanical investigations. Although the cultivators were, nine times out of ten, no botanists, yet, by close attention and constant examination of the plants, the peculiarities of particular stocks in their leaves, color, calyx, and pods, some became experts, and would mark a plant out among a thousand as one which would produce the longest staple and finest fiber. The stock would be marked by a red or white strip of cloth, and the cotton would be picked in by the planter himself. When all was gathered, perhaps not over a half dozen pounds to the crop, the staples would be carefully examined, samples sent to the particular buyers, and their opinion as to its value obtained. The seed was planted in gardens, which would produce, perhaps, sufficient to plant four or five acres in a field, distant from the common crop. As the seed thus improved or selected commanded the highest prices, and in some instances could not be purchased at any price, planters were careful not to publish to the world the peculiarity of growth by which they detected the finer qualities; and as the quality deteriorated rapidly from juxtaposition with ordinary crops, the sale of the seed, which the producers alone could keep up and improve, was sometimes as ample a source of revenue as the staple in market. The secret died with the old stock of sea-island planters, and is now lost to agriculture.

Cotton culture.

Sea-island.

Care and experience in improving the stock.

Selection for seed of the finest plants.

Sampling the results.

Separate planting of selected seed.

Sale of the improved seed.

Upon an examination of the staple of the last crop of sea-island on the plantations I find that it has deteriorated, in the last five years, far below the average, from carelessness and ignorance in not extirpating the "male" plants, and in all probability will never be brought up to its previous standard, but will ultimately become less valuable than the original importation from the Bahamas. Whether it is any material loss to the world is a question to be solved by machinery, for we know that now threads are produced from uplands of as fine and delicate a texture as were ever made from long cotton fifty years ago.

Present deterioration of the staple.

Sea-island and long-staple cotton can be cultivated to a greater extent and more profitably in the peninsula of Florida than in any Southern State, or, indeed, than in any other

Adaptation of the peninsula of Florida to the growth of sea-island cotton.

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Cotton culture. Sea-island.

part of the world. It is now established by extensive practical proof that this valuable staple can be produced in great perfection even in the very center of the peninsula. This fact is, no doubt, attributable to the almost insular position of East Florida. The importance which the production of this valuable staple must give to Florida will be duly estimated when it is considered that there are many millions of acres in that State that will yield it in luxuriant crops, and that it can be cultivated there without the fear of serious competition. The small islands on the coast of South Carolina and Georgia, to which production of this staple has been so long confined, are now so nearly worn out that the average product per acre does not exceed 120 lbs.—which is less than half of the average amount that the good lands of the peninsula will yield without manure—and there is no other portion of the United States, with the exception of East Florida, where this cotton can be produced as a staple except, perhaps, in Southern Texas.

Prospects of the future production in Florida.

Diminished fertility of the sea islands of South Carolina and Georgia.

Cultivation of the long-staple in Florida.

It is not more than twenty years since Florida may be said to have commenced the cultivation of long cotton, and yet the quantity annually produced there already amounts to about double that of the united crops of South Carolina and Georgia. It is true that the average quality of Florida cotton is not rated so high as that of the sea-island; but the difference in this respect is chiefly, if not entirely, attributable to the defective manner of preparing the former for market. It is a notorious fact that some of the Florida cotton has commanded the highest market price of the long-staple cottons; and it is therefore a fair inference that it is owing more to a deficiency of skill, or of care in its preparation for market, than to any inferiority of texture that the long cottons of Florida are rated lower than the sea-islands. When the Florida planter finds that he can make an average crop of 300 lbs. of this cotton to the acre, he is not likely to bestow as much care on its preparation for market, as the planter will on the sea islands, where 120 lbs. is a good average crop. It is in the quantity rather than in the quality that the Florida planter finds his best remuneration. But even should it prove true that the long cotton of Florida is in texture somewhat inferior to that of the sea-islands, this fact will detract but little from the vast wealth which this valuable staple is sure to bestow upon Florida. There are many millions of acres in the peninsula that will yield from 200 to 400 lbs. of this cotton per acre, and, as the demand for this species of cotton is steadily on the increase, and will soon call for an immense supply, it is evi-

Rating of Florida cotton in the market.

The present care is for quantity rather than quality.

Extent of Florida lands suitable for the culture.

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dent that if Florida possessed no other staple than long cotton this valuable product would of itself make her a very rich State. Should the time arrive—and that it will arrive at no distant day is probable—that the production of ten times the number of bales now consumed of long cotton will be required to meet the annual demand for this staple throughout the world, it will be to East Florida that the world must look for the production of this large supply. And I am safe in saying that the land adapted to long-staple cotton in Florida is capable of producing more than ten times the amount of this cotton now consumed by this country, Great Britain, and France. I am persuaded that there are at least one million of acres of land in Florida well adapted to the cultivation of the long cotton. There is no country now known that is likely to compete successfully with Florida in the cultivation of this cotton, since it has been practically demonstrated that no country in the world can produce cotton as cheaply as the United States; for it has been found impracticable to introduce skilled labor into the cotton regions of India, South America, and Egypt.

Cotton culture.

Sea-island cotton in Florida.

Florida's opportunity.

Superior conditions of the United States for the growth and supply of long-staple cotton.

The demand for American short-staple cotton has increased within a few years from 1,000,000 to 4,500,000 bales, and the demand is steadily increasing. Twenty years ago the sea islands of South Carolina and Georgia supplied the entire demand; but now we find that, in addition to this, the market for this staple requires the whole of the Florida crop, which increases steadily every year. It is well known that the machinery required for the manufacture of long cotton is very different from that employed in the manufacture of short cotton; and as the capacity of the sea islands for the production of long cotton was necessarily very limited, so was the construction of machinery for its manufacture proportionately restricted. But now that the manufacturers have assurance that there can be a very much larger supply of this staple produced in Florida, they have begun to adapt machinery on an extensive scale to suit its manufacture. And as this cotton is preferable to the common cotton in the manufacture of all fine fabrics, and especially in such as are composed in part of silk, it is but reasonable to infer that as soon as sufficient machinery shall have been constructed there will be a great and steady increase in the consumption of this material. These considerations, when added to the vast progress which the world is still destined to make in material wealth, the new and extensive fields of commerce recently opened in the East, and others

Demand for American cotton.

Peculiar machinery required for long-staple cotton.

With the increase of supply of the staple, machinery is adapted to its manufacture

Use of long-staple in fine and silk-mixed fabrics.

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yet to be opened, lead us to believe that much larger quantities of long cotton will be required to meet the world's demand.

Sea-island cotton.

SEA-ISLAND COTTON.

Crops, exports, and consumption.

Crops, exports, and consumption from 1865 to 1877.

Season.	Total crop.	Exports.	United States consumption.
	Bales.	*Bales.*	*Bales.*
1865–'66	19,015	18,231	1,100
1866–'67	32,228	30,706	1,597
1867–'68	21,275	19,859	1,670
1868–'69	18,662	17,239	1,388
1869–'70	26,507	24,716	1,399
1870–'71	21,609	19,905	1,672
1871–'72	16,845	15,584	1,526
1872–'73	26,289	23,469	1,523
1873–'74	19,912	18,873	2,113
1874–'75	17,027	15,046	2,192
1875–'76	14,996	12,936	1,915
1876–'77	17,823	13,234	4,068
1877–'78	24,825	16,295	9,451

Diseases, insects, etc.

DISEASES, INSECTS, ETC.

The cotton plant is subject to many misfortunes before it reaches maturity. In the localities whose soil produces the finest staple and most prolific yield it seems liable to the greatest dangers. In the northern districts of Georgia, South Carolina, and Alabama the crop seldom, if ever, proves an entire failure, though it is often curtailed by droughts and by very rainy seasons. It is true that in these districts we often discover indications of the diseases to which the plant is subject in more southern districts of these States, and in the bottoms of the Mississippi River. We have the "blight," the "rust," the "sore-shin," but we rarely find any of these diseases in a malignant form in the northern and cooler districts of the cotton-growing States.

The diseases of the coast and Mississippi River bottoms not so prevalent on the higher cotton lands.

Suggested reasons.

Many reasons have been assigned for this fact. It is supposed by many planters that the coolness of the winds in the early autumn is the cause of their escape in these northern districts from the insects most dangerous to the cotton plant in the warmer regions. Cotton of all localities in the cotton-growing States is subject to rust or blight. I find that many of the planters attribute this disease to poverty of the soil and to the plant. Its effect is to cause the plant to shed its leaves and the fruit to wither and die. Sometimes it is said to be produced by long-continued rainy seasons. I believe the disease known as "shedding" is the result of rust or blight. But all cotton plants shed

Causes of rust or blight.

Effects.

Shedding.

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more or less, for it would be impossible for the plant to mature all of its bolls, as a square is formed at almost every joint on every limb. Many of the blooms fall and many of the bolls die and drop before maturity. Diseases of cotton.

After the boll-worm we have the "scab," which is, I think, a result of rust; then the "sore-shin," which is most generally found on poor or thin land, particularly on thin sandy ridges. It is held by some that this is produced by lice on the plant, but by a greater number that it is caused by the stalk being wounded by the hoe during the first or second working. If this were the case, sore-shin would not be confined to poor land; and a learned writer on this subject believes that heavy fertilizing and thorough cultivation is a sure preventive of this disease. Scab. Sore-shin.

"Dry-rot" is another disease, to which the plant is subject, generally attacking the top bolls. The seed and lint first turn black; then a sore or scab appears, resembling a puncture with a sharp instrument; after the disease has taken possession of the whole pod, it opens and is found to be quite rotten. Dry-rot.

Destructive insects. *Insects.*

When the cotton plant is very young and tender it is particularly subject to the attacks of the cotton-louse (*Aphis*), which, by means of its piercer, penetrates through the outer coating, or *parenchyma*, of the leaf or tender shoots, and sucks the sap from the wound. The under part of the leaves or young shoots are the places mostly selected, and the constant punctures and consequent drainage of sap enfeeble the plant, causing the leaf to curl up, turn yellow, and subsequently wither away and fall to the ground. The young lice are extremely minute and of a greenish color, but when they become older they are about the tenth of an inch in length, and often of a dark-green color, or in some instances almost black. The color somewhat depends upon the health of the plant, as well as on that of the insect, or, perhaps, upon the food, as I have seen green and black lice promiscuously feeding upon the same plants. The female produces her young alive during the summer, when she may often be seen, surrounded by her numerous progeny, sucking the juice from the leaves. Some naturalists state that the females, late in the fall, produce eggs for the future spring generation. If so, it is in order to preserve the species, as the insects themselves are easily killed by cold and frost, and their increase would be incalculable were it not that nature has provided many enemies among the insect tribe

Cotton-louse. Effects on the plant. Appearance of the louse. Reproduction.

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Destructive insects.

to prevent their too rapid multiplication. Both males and females are said, at certain seasons, to possess wings, but the females and young in summer appear to be wingless.

The enemies of the louse.

"The principal insects that destroy the *Aphis* are the lady-bird, the lace-fly, and the *Syrphus*, all of which wage incessant war upon the lice, and devour all they can find. Another fly, the ichneumon, likewise lays an egg in the body of the louse, which, hatching into a grub, devours the inside of the still living insect until it eventually dies, clinging to the leaf even in death, and the fly makes its appearance from the old skin of the *Aphis*.

Boll-worm.

"The egg producing the boll-worm is deposited by a tawny yellowish-colored moth or miller (*Heliothes*) during the warm evenings in summer and fall. This insect may be seen hovering over the tops of the cotton blooms from about an hour before until an hour after sunset. This moth flits from flower to flower, depositing a single egg on each, which hatches in the course of three or four days, and the little

Its mode of preying upon the bolls.

caterpillar or worm immediately eats its way into the center of the inclosed bloom or boll, and, after devouring the interior, escapes to a leaf, where it soon casts its skin. The ruined bloom in the mean time 'flares' open and falls to the ground, and the young worm then attacks another bloom or boll in the same manner. At length, as it acquires size and strength, it is enabled to bore into the nearly matured bolls, which are entirely destroyed by its punctures, as at this

The effects.

period, if the interior is not devoured, the rain penetrates the boll, and the cotton becomes rotten and useless. The caterpillar, after attaining its full size, descends into the earth, where it makes a silky cocoon, interwoven with par-

Its transformations.

ticles of gravel and earth, in which it changes into a bright chestnut-brown chrysalis. Those which go into the ground in September and October appear as perfect moths about the end of November. Whenever a young bloom is seen in the field with the calyx spread open, it may be safely concluded that it has been attacked by the young boll-worm, and will soon perish and fall to the ground. If many of the fallen blooms are closely examined, they will mostly be found to have been previously pierced by this worm or some other

Appearance of the boll-worm.

pest. The worms vary much in color and markings, some being brown, while others are almost green; all, however, are more or less spotted with black, and slightly covered with short hairs. These variations of color, perhaps, may be caused by the food of the caterpillars, which appear in

The crysalis.

every shade between the two. The chrysalis is of a bright chestnut-brown and the moths of a tawny-yellow color.

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Destructive insects.

The upper wings are yellowish in some specimens, with a shade of green, but in others red. There is an irregular dark band running across the wing about one-eighth of an inch from the margin, and also a crescent-shaped mark near the center of the wing. Several dark spots, inclosing a white spot, are also discovered on the margin. The under wings are lighter colored, with a broad black border on the margin, and veined distinctly with the same color. In the black border, however, there is a brownish-yellow spot of the same color as the rest of the under wing, which is more distinct in some specimens than in others, but may be plainly perceived."

The boll-worm and its moth.

EUROPEAN CONSUMPTION OF COTTON.

European consumption of cotton.

There is no country in Europe, with the exception of France, that can pretend to compete with England in the manufacture of cotton goods and spinning of yarn. But when the character and development of that industry in the respective countries is compared, it will be readily seen that France, unlike England, offers no extended market for the produce of the Southern States. France consumes annually within her own borders about 150,000,000 lbs. of cotton for clothing her people, while nearly double that quantity is so used by the people of the British Isles. The exports of cotton manufactures of all kinds from France reach only one-tenth the value of those sent from England to other countries. As India is the largest market for the productions of British cotton looms, so is Algeria the principal importer of those of France. They each take about one-fourth the entire exportations of cotton goods from either country. The French cotton goods sold in the English and American markets owe their value rather more to the designer and dyer than to the planter or weaver. Their consumption, therefore, does not admit of any very rapid or wide increase. French taste and French chemistry, wherever they are applicable, have deservedly won for French textile fabrics a superiority universally recognized. The extent of the cotton manufactures of France will be seen by reference to the tables subjoined. A few particulars may, however, be here introduced. The average quantity of raw cotton imported into France, and retained for the use of her mills, in the five years 1848 to 1852, was about 132,000,000 lbs. She likewise bought cotton yarns, chiefly from England, to a value of about 700,000 fr. per annum. In 1853 her net receipts of raw cotton were increased to 165,000,000 lbs., valued at 125,000,000 fr., and her imports of yarns were

England the great consumer.

The French market much more limited.

India is England's largest consumer of cotton goods.

Algeria the best customer of France.

The special merit of French cotton goods.

French imports of raw cotton and yarns.

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European consumption of cotton.

French exports.

worth 1,400,000 fr. The cotton goods exported from France in 1853 were cleared at a valuation of 71,900,000 fr., and her cotton yarns at 866,000 fr. These amounts exhibit but a slight increase on the average of the previous five years. The cotton trade of France for 1859, 1860, 1861, 1862, and 1863 figured as follows:

Cotton trade of France.

French commerce in raw cotton, 1859 to 1863.

Years.	Importations.	Exportations.	Excess of imports.	Net value.	American portion.
	Pounds.	*Pounds.*	*Pounds.*	*Francs.*	*Pounds.*
1859.....	201, 901, 408	22, 238, 146	179, 663, 264	153, 741, 989	179, 600, 000
1860.....	306, 675, 848	34, 535, 257	272, 140, 591	202, 710, 114	252, 667, 555
1861.....	282, 432, 832	11, 022, 145	271, 410, 687	270, 631, 594	241, 445, 321
1862.....	101, 842, 286	16, 413, 960	85, 428, 325	126, 157, 880	487, 573
1863.....	141, 580, 298	19, 480, 813	122, 099, 485	177, 168, 499	10, 000
Total	1, 034, 432, 672	103, 690, 321	930, 742, 352	930, 410, 076	674, 210, 449

Of the quantity of raw cotton received into France, there were imported through English ports (per British Board of Trade returns)—

French imports *via* England.

French importation via England.

1858.	5,261,200 lbs., valued at	£148,183
1859.	7,437,888 lbs., valued at	185,693
1860.	13,028,848 lbs., valued at	306,610
1861.	12,487,440 lbs., valued at	371,926
1862.	61,238,576 lbs., valued at	3,737,366
1863.	80,000,000 lbs., valued at	5,317,543

French exports to England.

France sent to England in the same years (per British Board of Trade returns) the following quantities, viz:

French exportation to England.

1858.	4,264,560 lbs., valued at	£157,160
1859.	3,349,136 lbs., valued at	100,255
1860.	2,186,688 lbs., valued at	62,562
1861.	955,172 lbs., valued at	38,840
1862.	5,491,248 lbs., valued at	327,323
1863.	1,683,696 lbs., valued at	160,108

Value of raw cotton imported by France *via* England.

The value of the raw cotton exported from England to France in 1861, 1862, and 1863, was as given below, and was the growth of the under-mentioned countries:

French importation from England.

Countries.	1861.	1862.	1863.
Growth of Southern States	£216,503	£703,577	£329,259
Growth of Brazil	2,951	87,085	50,820
Growth of Egypt	16,590	118,381	149,426
Growth of British India	135,882	2,810,636	4,582,548
Growth of other countries		17,687	205,490
Total	371,926	3,737,366	5,317,543

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European consumption of cotton.

It will be noticed by these tables that France carries on with England both an importing and an exporting trade in raw cotton. She, however, buys more cotton from England than she sells to her. Her exports thither consist principally of the American staple, of which sort she sometimes imports more than she needs. Her supplies from England of late are mostly of Indian cotton. The chief exportations of cotton from Havre are by railway to Switzerland; next in extent are those to Holland and Sardinia; and smaller shipments are made to the other Italian states, to Spain, and to Austria.

Nature and direction of French exports and imports.

Belgium imports 75,000 bales of cotton of 400 lbs. each, one-half of which is the growth of the Southern States, the other half East Indian cotton, received through England. Her re-exports in the manufactured state amount to one-eighth of all she imports. In Spain, cotton culture and manufacture were introduced by the Moors, and were continued by them to some extent for several centuries. The cotton grown in the kingdom of Granada was of good staple and much prized. Barcelona also was famed for her sail-cloth. The cotton sail-cloth of the present day, therefore, is no new article of commerce. The *fustianeros* of Spain wove stout cotton goods, from which the term "fustian" is derived. Cotton paper was made by the Spanish Arabs. The strong religious hatred that existed between the two rival races on the Peninsula prevented these Oriental arts from extending further west, or taking a strong hold on the Christian population; and, consequently, at the fall of the Saracen empire in Spain the cotton culture and manufacture relapsed into insignificance. About a quarter of a century ago the cotton manufacture began to revive, from which time, up to the period of the American war, it had slowly increased. Spain imports annually about 100,000 bales of cotton of 400 lbs. each, 80 per cent. of which is the growth of the Southern States. She draws from Brazil about 6,000 bales of the same weight, from Porto Rico about 700 bales, Cuba about 300 bales, and the remainder from British India *via* England and the Mediterranean. She also imports about 200,000 lbs. of cotton yarn and 3,500,000 yards of cotton goods—the yarns and goods chiefly from England. Her population is 16,500,000, who consume annually 3 lbs. of cotton per head.

Belgian imports.

American and Indian.

Spanish cotton under the Moors.

Cotton paper of the Arabs.

Revival of cotton manufacture in Spain.

Imports—whence derived.

Consumption.

Portugal imports about 5,000 bales of cotton annually, nine-tenths of which quantity is received from the Brazils, and the remainder is the growth of the Southern States, obtained through England. Portugal is a large customer

Portugal.

Imports.

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European consumption of cotton.

to England for cotton yarns and cotton goods, from whom she purchases annually about 300,000 lbs. of the one and 55,000,000 yards of the other. Her population is 3,600,000, whose consumption of cotton is at the rate of 4 lbs. per head.

Portugal.

The Portuguese, who were the discoverers of the passage to India *via* the Cape of Good Hope, made large importations of cotton stuffs and muslins into Europe; but they did not attempt to establish cotton manufactures in their own country.

Italy.

Cotton was introduced into Italy, as a garden plant, at a very early date. It was cultivated as a crop in the eleventh century along the shores of the Gulf of Taranto, where its manufacture sprang up. It was the fashion for ladies to occupy their spare time in spinning yarn and knitting stockings, which were greatly admired and sold for high prices.

Former culture.

Italian muslins superseded by Indian, and those by English.

Italian muslins were very much in vogue until the end of the last century, when they were superseded by those of India, and in turn by those of England. During the wars of the first Napoleon, when the "Continental system" was in operation, and cotton could not be obtained from other sources in Europe, Italy produced a considerable quantity of that staple. So much so, that the olive tree and the mulberry, which at one time were the principal objects of cultivation, were destroyed in order to make room for cotton. This state of affairs existed about ten years. After peace was restored, the prices of cotton fell so low that cultivation shrank back into its former narrow limits. About 40,000 bales of cotton are now grown annually in Italy, and she imports a similar quantity, three-fourths of which is of the growth of the Southern States. The Italian States take from England 12,000,000 lbs. of cotton yarn and 100,000,000 yards of cotton goods.

Revived culture in the Napoleonic period.

Growth and imports.

Prussia.

The consumption of cotton in Prussia is only about 70,000 bales of 400 lbs. each, along with 12,000,000 lbs. of yarn and 4,000,000 yards of cotton goods, which she purchases from England. In Saxony about 80,000 bales of cotton are consumed by the mills. That quantity is about equally divided between Southern and East Indian cotton. Saxony is also a large consumer of English yarns. Bavaria holds an equal position with Saxony toward the cotton trade.

Imports and consumption.

German States.

Consumption.

In all the German States about 3 lbs. of cotton per head are consumed every year by their people. One-half of that quantity is produced by their own mills, the other half is in cotton goods imported from England. The German States are supplied with the cotton consumed in their factories, chiefly through the Hanseatic cities of Hamburg and Bre-

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men. German cotton goods are exported to the American States to the amount of, generally, $2,000,000 a year. These goods are made principally in Saxony. *European consumption of cotton.*

Austria, hitherto, has conducted quite a respectable commerce in cotton with the American States. She has made a pretty rapid stride of recent years in the cotton manufacturing industry. She purchases about 170,000 bales of cotton of 400 lbs. each, one-third of which reaches her through England, from whom she buys about 5,000,000 lbs. of yarn and 20,000,000 yards of cotton goods. Austria. Imports.

The cotton manufactures of Switzerland are known to have existed as early as 1423. In that year a decree was issued by the canton of Lucerne, directing that cotton goods should be sold by weight. It is conjectured that it is from this decree that the custom originated of selling, entering, and clearing cotton goods by weight as well as by measure. The principal cotton marts at that time were France, Germany, and Italy. Switzerland manufactures about 75,000 bales of cotton, or 30,000,000 lbs. per annum. Four-fifths the quantity is imported into Havre and passed through France by railway, at a heavy expense. The other fifth is obtained through the ports of Germany. One-half the cotton used by the mills of Switzerland is of Southern growth. She also imports 2,000,000 lbs. of cotton yarn and 30,500,000 yards of cotton goods. The population of Switzerland is about 2,500,000, and she consumes within her limits 3 lbs. per inhabitant, or 7,500,000 lbs. of cotton a year, and exports in goods, including loss by spinning, 31,000,000 lbs. per annum. She ranks next to England, in comparison with her population, in the production of cotton yarns and cotton goods. Her cotton manufactures have largely increased during the last thirty years, without the aid of protective duties, notwithstanding the enormous expense she is subject to in obtaining her supplies of the raw material, and sending overland to other countries the surplus product of her looms. Being situated on the confines of states which impose high protective tariffs on the importation of cotton fabrics, she has pursued the opposite policy, and admitted all goods free of duty. This has caused her people to obtain cheap cotton fabrics, and they therefore have been enabled to smuggle them with advantage into the territories of her neighbors. This contraband trade has yielded large profits. The prosperity of Switzerland is also due to the abundance of her water-power, and the great energy, intelligence, and industrial genius of her population.

Switzerland. Cotton manufactures in 1423. Present manufactures. Imports. Consumption. Greatly increased manufacture of late without the aid of protective duties. Free trade in the midst of protective-tariff nations. Contraband trade.

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European consumption of cotton.

The Dutch, who succeeded in depriving the Portuguese of a portion of their Eastern colonies, imported the cotton goods of India in large quantities, and, in the latter part of the sixteenth century, established factories of their own, to imitate the fabrics of the East. The cotton manufacture

Holland.

has continued to this day. Holland imports about 110,000

Imports.

bales of cotton, of 400 lbs. each, three-fourths of which enters through Rotterdam, and the remaining fourth through Amsterdam. She likewise imports from England 35,000,000 lbs. of cotton yarn and 35,000,000 yards of cotton goods.

Sweden and Norway.

Sweden imports 25,000 bales of cotton, of 400 lbs. each. One-third of her receipts of that staple comes through England, from whom she also purchases 1,000,000 lbs. of cotton

Imports.

yarn and 1,200,000 lbs. of cotton goods. Norway imports very little raw cotton. She buys from England 125,000,000 lbs. of cotton yarn and upwards of 2,000,000 yards of cotton goods.

Denmark.

Denmark imports from England 2,000,000 lbs. of cotton yarn and 3,500,000 yards of cotton cloth.

Russia.

Russia, previous to the American war, imported upwards

Imports.

of 200,000 bales of cotton a year, and, of that, one-third was received direct from American ports and the remainder, with the exception of some small lots of Persian growth, was obtained in England. Russia buys from England about 4,000,000 lbs. of yarn and 5,000,000 yards of cotton goods. Russia, like other countries, has been reducing her reserve stock of cotton and cotton goods for several years.

Turkey.

Turkey does not purchase any raw cotton, but she buys an-

Imports of cotton goods.

nually 25,000,000 lbs. of cotton yarn and 300,000,000 yards of cotton goods from England. She exports moderate quantities of raw cotton to Western Europe.

The figures that are given for the cotton trade of the several Continental countries, other than France, represent their ordinary commerce. An inflated condition of affairs in connection with that trade existed just previous to the American war; and all the Continental markets were likewise largely overstocked with British cotton goods, as the tables of exportations from England for 1860 and 1861 testify. To such an extent was this the case that Russia shipped back to England, in 1862, 304,066 lbs. of cotton yarn, and Germany returned large quantities of calicoes. Those shipments, which seemed like "sending coals to Newcastle," actually paid handsome profits.

Egypt.

Egypt imports from England about 2,000,000 lbs. of cotton

Imports.

yarn and 70,000,000 yards of cotton goods. She is the only

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country other than America that exports more cotton in the raw state than she imports in the manufactured condition; and yet she did not commence the cultivation of that staple in earnest until 1818. It seems strange that the two countries that were the latest in engaging in that species of agriculture should be the only countries that can produce more than they need for their own wants. A great deal of cotton is used in Egypt for making up divans, the usual furniture of the country.

Egyptian exports and imports.

China takes from England every year about 10,000,000 lbs. of cotton yarns and 200,000,000 yards of cotton cloth, as well as 200,000 bales of cotton from India; also from $1.500,000 to $2,000,000 in value of American cotton goods. Nearly all the other Eastern countries are customers to England for her cotton fabrics. Africa, too, is supplied by the looms of Lancashire.

China.

Imports of cotton, yarn, and cloth.

Africa.

Estimated number of spindles in Europe and the United States in 1877 and the annual consumption of cotton.

Spindles in Europe and the United States.

Countries.	Number of spindles in round numbers.	Pounds per spindle.	Consumption in bales of 400 pounds.
Great Britain	39,500,000	33	3,258,000
Continent	19,500,000	33	2,584,000
Total Europe	59,000,000	.....	5,842,000
United States	10,000,000	63	1,575,000
Grand total	69,000,000	.....	7,417,000

According to statistics there were at work in India in 1877 about 1,231,000 spindles. The returns show 75 lbs. per spindle per annum. The progress of cotton manufacture in India is shown by the following table:

Spindles in India.

Number of spindles and consumption of cotton in India.

Consumption of cotton in India.

Year.	Spindles at work.	Cotton consumed.	
		Per annum in bales of 330 lbs.	Average per week in bales.
1861	338,000	65,000	1,250
1874	593,000	114,000	2,190
1875	886,000	170,000	3,270
1876	1,124,000	216,000	4,150
1877	1,231,000	237,000	4,560

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I think it important to furnish some interesting facts in counection with the manufacture of cotton, and also some statistics relative to the cotton trade of this and other countries, which will be found in the tables annexed to this report. Some of the information I procured from the Department of Agriculture and a portion from a very valuable little book edited by Mr. A. B. Shepperson, of New York.

Acknowledgments to Mr. A. B. Shepperson.

P. M. B. YOUNG,
Additional Commissioner.

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APPENDIX.

Comparison of the American cotton crops of the thirteen seasons immediately preceding with the thirteen seasons since the war.

Season.	Total crop in thousands of bales.	Season.	Total crop in thousands of bales.
1848–'49	2,840	1865–'66	2,278
1849–'50	2,204	1866–'67	2,233
1850–'51	2,415	1867–'68	2,599
1851–'52	3,126	1868–'69	2,434
1852–'53	3,416	1869–'70	3,114
1853–'54	3,075	1870–'71	4,347
1854–'55	2,983	1871–'72	2,974
1855–'56	3,665	1872–'73	3,874
1856–'57	3,094	1873–'74	4,130
1857–'58	3,257	1874–'75	3,831
1858–'59	4,019	1875–'76	4,632
1859–'60	4,861	1876–'77	4,474
1860–'61	3,849	1877–'78	4,774
Total yield for 13 years previous to the war	42,804	Total yield for 13 years since the war	45,694

The excess of yield of 1865–'78 over 1848–'61 is 2,890,000 bales.

Statement of annual crops, exports, and United States consumption of cotton since 1841.

(In thousands of bales.)

Season.	Total crop.	Exports.			Home consumption.	
		To Great Britain.	To Continent.	Total exports.	Northern mills.	Southern mills and burnt.
1841–'42	1,684	936	529	1,465	208	(*)
1842–'43	2,379	1,470	540	2,010	325	(*)
1843–'44	2,030	1,202	427	1,629	347	(*)
1844–'45	2,394	1,439	645	2,084	389	(*)
1845–'46	2,100	1,102	565	1,667	423	(*)
1846–'47	1,779	831	410	1,241	428	(*)
1847–'48	2,423	1,324	534	1,858	532	75
1848–'49	2,840	1,538	690	2,228	518	112
1849–'50	2,204	1,107	483	1,590	488	107
1850–'51	2,415	1,418	571	1,989	404	60
1851–'52	3,126	1,669	775	2,444	588	111
1852–'53	3,416	1,737	791	2,528	650	153
1853–'54	3,075	1,604	715	2,319	592	145
1854–'55	2,983	1,550	694	2,244	571	135
1855–'56	3,665	1,921	1,034	2,955	633	138
1856–'57	3,094	1,429	824	2,253	660	154
1857–'58	3,257	1,810	780	2,590	452	143
1858–'59	4,019	2,019	1,002	3,021	760	167
1859–'60	4,861	2,669	1,105	3,774	793	186
1860–'61	3,849	2,175	952	3,127	650	193
1861–'65†						
1865–'66	2,278	1,262	293	1,555	541	127
1866–'67	2,233	1,216	341	1,557	573	150

* No estimate. † Civil war—no record of cotton movement.

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Statement of annual crops, exports, &c.—Continued.

(In thousands of bales.)

Season.	Total crop.	Exports.			Home consumption.	
		To Great Britain.	To Continent.	Total exports.	Northern mills.	Southern mills and burnt.
1867–'68	2,599	1,228	428	1,656	800	168
1868–'69	2,434	989	458	1,447	822	173
1869–'70	3,114	1,475	704	2,179	777	80
1870–'71	4,347	2,368	800	3,108	1,072	91
1871–'72	2,974	1,474	483	1,957	977	120
1872–'73	3,874	1,920	756	2,676	1,063	138
1873–'74	4,130	1,852	959	2,811	1,192	128
1874–'75	3,831	1,833	841	2,674	1,071	130
1875–'76	4,632	2,005	1,227	3,232	1,220	134
1876–'77	4,474	1,994	1,034	3,028	1,302	127
1877–'78	4,774	2,047	1,309	3,356	1,345	145

Acreage in cotton of the ten cotton-growing States, as reported by the United States Agricultural Bureau, 1876 to 1878.

States.	Season of 1876–'77.	Season of 1877–'78.		Season of 1878–'79.	
	Number of acres.	Percentage compared with 1876–'77.	Number of acres.	Percentage compared with 1877–'78.	Number of acres.
North Carolina	609,000	96	584,640	101	590,486
South Carolina	945,500	97	917,135	103	944,649
Georgia	1,515,000	101	1,530,150	102	1,560,753
Florida	165,000	101	166,650	100	166,650
Alabama	1,732,250	102	1,766,895	104	1,837,571
Mississippi	1,976,000	104	2,055,040	100	2,055,040
Louisiana	1,260,000	106	1,335,600	101	1,348,956
Texas	1,483,500	115	1,706,025	106	1,808,386
Arkansas	1,133,000	105	1,189,650	98	1,165,857
Tennessee	741,000	102	755,820	98	740,704
Total acreage	11,560,250	.....	12,007,605	.....	12,219,052

Highest and lowest prices in New York for middling upland cotton, from January 1 to December 31 in each of the years named.

Year.	Highest.	Lowest.	Year.	Highest.	Lowest.	Year.	Highest.	Lowest.	Year.	Highest.	Lowest.
1826	14	9	1839	16	11	1852	10	8	1865	122	33
1827	12	8	1840	10	8	1853	11	10	1866	52	32
1828	13	9	1841	11	9	1854	10	8	1867	36	15½
1829	11	8	1842	9	7	1855	11	7	1868	33	16
1830	13	8	1843	8	5	1856	12	9	1869	35	25
1831	11	7	1844	9	5	1857	15	13	1870	25⅝	15
1832	12	7	1845	9	4	1858	13	9	1871	21½	14⅜
1833	17	9	1846	9	6	1859	12	11	1872	27⅛	18⅛
1834	16	10	1847	12	7	1860	11	10	1873	21⅝	13⅜
1835	20	15	1848	8	5	1861	28	11	1874	18¼	14⅛
1836	20	12	1849	11	6	1862	68	20	1875	17¼	13 1/16
1837	17	7	1850	14	11	1863	88	54	1876	13⅜	10¼
1838	12	9	1851	14	8	1864	190	72	1877	13 1/16	10 1/16

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Belgium,	Great Britain (with Australia, Canada, India, etc.),	Japan,	Spain,
Brazil,	Greece,	Morocco,	Sweden,
China,		Netherlands,	Turkey,
Denmark,		Norway,	United States (with individual States).
Egypt,		Persia,	
France (with Algeria),		Portugal,	

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Arabia,	Greece,	Portugal,
*Argentine Republic,	Hawaii,	Russia,
*Austria-Hungary,	Hayti,	*Spain,
*Belgium,	*Italy,	Sweden,
Brazil,	Japan,	*Switzerland,
*China,	Mexico,	Tunis,
Denmark,	*Netherlands,	*United States,
Egypt,	Norway,	Venezuela,
*France,	Paraguay,	West Indies.]
*Germany,	Persia,	

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Argentine Republic,	Colombia, United States of,	Italy,
Austria-Hungary,	Ecuador,	Japan,
Belgium,	France (with Algeria and other colonies),	Luxemburg,
Bolivia,	Germany (and provinces),	
Brazil,		

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[NOTE.—*The iron and steel exhibit is indexed in detail under the titles of the producing countries, viz:*

Madagascar,	Portugal,	Transvaal Republic,
Mexico,	Russia (with Finland),	Turkey,
Morocco,	Spain,	United States (with individual States).
Persia,	Sweden,	
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